# POWER

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ELY C. HUTCHINSON, *Editor*

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# Dr. Ira N. Hollis

NEWS of the death of Ira Hollis must have come to thousands of others, as it came to me, with a sense of personal bereavement.

There are those who command respect and admiration but whom we are content to admire from afar. There are those who touch the heartstrings as well as the mentality and whose coming makes you want to open your arms.

Of such was Ira Hollis.

I don't remember when I first met him or when I didn't know him, but I know that with his passing something that ministered to its amenities and humanities has gone out of my life.

He was a graduate of Annapolis in the Class of 1878, and his droll stories of and badinage with Dean Mortimer E. Cooley, who was his room-mate, have added zest to many an occasion

His experience in the navy, his world-wide acquaintance with worthwhile people, his wealth of reading and breadth of thinking made him the dominant figure in any group the currency of which was both anecdote and intelligent comment upon current events.

In his twenty years of service as professor of engineering at Harvard and twelve subsequent years as president of the Worcester Polytechnic Institute he impressed himself upon the lives of thousands of students whose demonstrations of cordial remembrance were a delight to his declining years.

He was one of the early members of the American Society of Mechanical Engineers, having joined in 1884. He became its president in 1917, and in 1928, together with his pal Cooley, was made an honorary member.

He was a member of many other professional societies and the recipient of numerous honorary degrees. But that which he valued most was sympathetic companionship. I hope he knows now in how complete a measure this wish has been fulfilled.

# EDITORIALS

## The Flue Dust Problem

MEN in responsible charge of the design and operation of public utilities and industrial power plants—heed this message.

Just as certain as "time and tide wait for no man," popular sentiment is approaching the point of public demand for the elimination of the nuisances which result in the atmospheric pollution prevailing in many of the cities and industrial centers in the United States. It is not to be denied that soot and dust from the power houses contribute largely to the condition. Although they are by no means the only, nor the worst offenders, the fact that power companies are even now the prey of predatory politicians makes their position delicate.

The problem is not new; far from it. The causes are well known, and although some companies are spending large sums for systematic research the problem is not organized. There have been many gestures in the direction of its solution, but because the full answer is not readily found, it is customary to tell of the difficulties, of the excessive expense, and of the conscientious but unsuccessful efforts to remove all the objectionable matter from the flue gases. There the subject is usually allowed to rest, and the feeling prevails among the power producers that none can be accused of failure to regard the public interest.

Compared with the average large American cities, the cities of Europe are models of atmospheric purity. They have a long way to go, abroad, before they may hope to approach our degree of air pollution. It is quite apparent, however, that America will be left to hold this record without fear of competition.

England recently witnessed a flat refusal of the government to permit the building of a power plant until a guarantee was given by the power company that there would be no soot, dust, or sulphurous pollution of the atmosphere. In another case, the people claimed destruction of property from matter carried by the flue gases of a long-established power house. The courts have ordered the power company either to eliminate the objectionable matter within a certain time, or to remove the plant.

In recognition of the seriousness of the problem, German fuel experts have spent two years in making a survey of the status of flue dust prevention on the Continent, and this Fall will send an investigator to the United States.

Although some of the public utilities already know these things, others and many of the industrial power plants do not.

In recognition of its responsibility to the power field, *Power* proposes to bring this problem out of its seclusion for a sun bath. There is no virtue in avoiding it. The sooner it becomes a live issue throughout the power field the earlier will be its solution. It is much better that this shall be done voluntarily rather than be left to social meddlers and politicians.

## Selling Research to the Banker

EARLY in October, it is announced, more than two hundred industrial executives and bankers will board a special train to go on a tour of discovery. They will not see Antarctica or the Tibetan Plateau, but things more wonderful—and equally strange—they will find in the great research laboratories of American industry. Their visiting list includes: Bell Telephone, General Electric, General Motors, Wright Air Field, American Rolling Mills, Aluminum Company of America, Mellon Institute, and the Bureau of Standards. With a whole day in each of the industrial laboratories, and two at Washington, it is inevitable that the bankers and industrial executives will take home a new vision of science as the foundation of industrial progress.

This unique inspection trip, lasting nine days in all, and sponsored by the National Research Council, American Bankers Association, and other important agencies, gains significance from the key positions of the participants. Scientific research is no longer the maltreated step-child of industry, but its far-reaching commercial possibilities are yet appreciated but dimly by many industrialists and bankers—particularly the latter.

Here, then, is evidence that a great opportunity has been seized. Rightly or wrongly, the bankers wield im-

mense power over industry. The holder of the purse strings has an advantage that cannot be disregarded, particularly where large expenditures are needed for "non-productive" purposes. If one is in the steel business it is simple enough to finance a new open-hearth furnace to meet a growing demand for rails or sheet. It is not so simple to get support for large-scale research on projects whose outcome is indeterminate.

A splendid way to improve the situation is to educate the bankers. Such a trip as that planned for October is cheap at almost any price if it accomplishes this.

## The St. Lawrence River Development

PRESIDENT HOOVER'S efforts to alleviate the present business depression by speeding up river and harbor improvements are in line with his policy to return business to normalcy. Within the country much can be done to accelerate these projects. When the St. Lawrence waterway is considered the prospects are not promising. In fact, the present may not be the time to attempt reopening treaty negotiations with Canada for development of the international section. The sentiment created in Canada by the Hawley-Smoot tariff bill has not had time to moderate, and a new government has recently been elected, very much as a repercussion of our tariff legislation.

Aside from this there are other conditions that operate against Canada's assuming heavy financial obligations at this time to develop a St. Lawrence deep waterway. Chief among these is the fact that the Canadian government is already engaged in developments that require large investments. As the development of this river is working out, it appears that Canada can have a deep waterway in the St. Lawrence at comparatively small expense on its part. The Soulanges section is now being developed as a deep waterway and a power project by private capital, and at an opportune time the Lachine section will likely be developed in the same way. This will provide a deep waterway from Montreal to the international section. The Canadian government has already enlarged the Welland Canal to the dimensions proposed for the St. Lawrence waterway. Thus Canada can have developed within her territory those sections of a deep waterway to the Great Lakes at little expense to the government other than that already made. For this reason, when considering the international section, Canada will probably insist that the St. Lawrence deep waterway be a Canadian project.

The St. Lawrence River development cannot be discussed without considering the power situation, for on this river there is five million horsepower. Ontario is one of the largest power users interested in this project. The international section of the river lies between the Province of Ontario and New York State. Although the latter is apparently interested in immediately developing the power in that section, the Province of Ontario probably is not. The Hydro-Electric Commission of Ontario has contracts for large blocks of power at very low rates, for future delivery, and can obtain others when necessary. The commission has a half interest in a large development now being made on the Ottawa River. There are other large projects possible on the Ottawa in which Ontario has a half interest and which can be made at nominal cost. These and others will supply Ontario with all the power required in the region that can be reached from the St. Lawrence River.

Looked at from a business angle, it would appear that neither the Canadian government nor the Province of Ontario should now be enthusiastic about making the investment necessary for the speedy development of the St. Lawrence River.

The difficulties in the way of developing the international section are not all on the Canadian side. There are many in the United States that must be overcome before work can be started. Canada, like the United States, has a serious unemployment problem. If the desire to alleviate this is sufficiently strong it may advance the time when the complete development of the St. Lawrence River will be started. Otherwise, it is something that is apparently several years away.

## It's Hardest to Do the Easiest Thing

A DIESEL ENGINE is so self-contained that only a few instrument readings need be taken to permit the engineer to ascertain a plant's efficiency. In spite of this, but a small number of Diesel plants, almost too small to be termed a percentage, attempt to keep records of anything but the fuel consumed and the power output. In fact even those two records are absent in many plants.

Probably an engineer should be motivated to operate efficiently by some ethical ideal; but, getting down to the practical side of things, he will find, as is pointed out in an article in this number, that keeping records is a strong argument to use when outlining the desirability of a salary increase.

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## POWER *Stands for . .*

1. Making Power When It Should Be Made
2. Buying Power When It Should Be Bought
3. Cheaper Power Through Modern Equipment
4. Easier Financing of Equipment Purchases
5. Better Use of Byproduct Heat and Power
6. Operating Methods That Save Money
7. Less Waste in Transmission and Application
8. Prevention of Smoke, Within Reason

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# DIPHENYL
## ($C_6H_5$—$C_6H_5$)

## *May Solve Reheating Problem*

By G. B. CUNNINGHAM
*Swann Chemical Company*

**Physical and chemical properties indicate commercial success as medium for reheating steam to full initial temperature in high-pressure plants**

REHEATING of steam at some intermediate pressure is universally recognized as a necessity in high-pressure condensing power plants. Where the initial pressure exceeds 500 lb., or thereabout, and steam is expanded through turbines without reheating, the percentage of moisture in the final stages is sufficient to cause serious corrosion and loss of efficiency.

To date this reheating has been accomplished in two ways. More commonly, the steam is carried back to the boiler room after expansion through the high-pressure turbine. It is then passed through resuperheating tubes installed in one of the regular boilers, or in a special reheat boiler. The reheated steam is conducted back to the turbine room, where it passes to the low-pressure turbine.

The other established method of reheating steam is to pass it through a heat exchanger placed near the turbine. This is generally operated by saturated or superheated steam at boiler pressure.

Each of these methods has its advantages and disadvantages. Reheating in the boiler room makes it possible to restore to the steam its full initial temperature, generally 700, 725, or 750 deg. To avoid excessive investment with this arrangement it is necessary to allow a very considerable pressure drop from high-pressure exhaust to low-pressure inlet.

The use of a steam reheater reduces both the pressure drop and the initial investment, but it, in turn, has a serious disadvantage, namely, that the reheat temperature obtainable is far below that desired.

That this must be true will be clear from a study of the steam tables. The saturation temperature of steam at 1,200 lb. pressure is about 570 deg. F., and the reheat temperature must in any case fall well below this, if steam at 1,200 lb. pressure is used.

One could, of course, use a special reheat boiler operated close to the critical pressure of 3,226 lb. per square inch. Few would care to attempt this, not only because of operating difficulties, but because the cost of steam reheat equipment for such pressures would exceed that

# PHYSICAL PROPERTIES OF DIPHENYL

| Temperature Deg. F. | Temperature Deg. C. | Pressure Vacuum In. Hg. | Pressure Lb. per Sq. In. Abs. | Heat Contents, B.t.u. per Lb. Liquid | Latent | Total | Density, Lb. per Cu.Ft. Liquid | Vapor |
|---|---|---|---|---|---|---|---|---|
| 156.6 | 69.2 | 29.9 | 0.015 | 0.0 | 190.9 | 190.9 | ..... | ..... |
| 200 | 93.3 | 29.8 | 0.060 | 17.7 | 175.0 | 192.7 | 60.85 | 0.00108 |
| 300 | 148.7 | 28.5 | 0.701 | 61.9 | 154.0 | 215.9 | 58.08 | 0.0117 |
| 320 | 160.0 | 27.8 | 1.050 | 71.4 | 152.0 | 223.4 | 57.52 | 0.0170 |
| 340 | 171.1 | 26.8 | 1.53 | 81.3 | 151.0 | 232.3 | 56.93 | 0.0239 |
| 360 | 182.2 | 25.5 | 2.18 | 91.4 | 149.5 | 240.9 | 56.36 | 0.0336 |
| 380 | 193.3 | 23.7 | 3.06 | 101.8 | 149.0 | 250.8 | 55.80 | 0.0460 |
| 400 | 204.4 | 21.4 | 4.20 | 112.6 | 148.0 | 260.6 | 55.24 | 0.0616 |
| 420 | 215.6 | 18.4 | 5.67 | 123.7 | 147.0 | 270.7 | 54.67 | 0.0804 |
| 440 | 226.7 | 14.6 | 7.54 | 135.1 | 145.0 | 280.1 | 54.09 | 0.1050 |
| 460 | 237.8 | 9.8 | 9.87 | 146.8 | 142.0 | 288.8 | 53.53 | 0.1410 |
| 480 | 248.9 | 4.0 | 12.80 | 158.8 | 138.5 | 297.3 | 52.93 | 0.1800 |
| 491.5 | 255.3 | 0.0 | 14.70 | 165.8 | 136.5 | 302.3 | 52.59 | 0.210 |
| | | Lb. per Sq. In. Gage | | | | | | |
| 500 | 260.0 | 1.6 | 16.3 | 171.0 | 135.0 | 306.0 | 52.32 | 0.236 |
| 520 | 271.1 | 5.9 | 20.6 | 183.5 | 131.0 | 314.5 | 51.69 | 0.310 |
| 540 | 282.2 | 11.0 | 25.7 | 196.1 | 127.5 | 323.6 | 51.05 | 0.395 |
| 560 | 293.3 | 17.0 | 31.7 | 208.9 | 124.5 | 333.4 | 50.41 | 0.495 |
| 580 | 304.4 | 24.1 | 38.8 | 221.8 | 121.0 | 342.8 | 49.73 | 0.615 |
| 600 | 315.6 | 32.3 | 47.0 | 234.8 | 117.0 | 351.8 | 49.04 | 0.750 |
| 610 | 321.1 | 36.9 | 51.6 | 241.4 | 115.5 | 356.9 | 48.70 | 0.830 |
| 620 | 326.7 | 41.9 | 56.6 | 248.0 | 114.0 | 362.0 | 48.35 | 0.910 |
| 630 | 332.2 | 47.2 | 61.9 | 254.6 | 112.5 | 367.1 | 47.99 | 0.995 |
| 640 | 337.8 | 52.8 | 67.5 | 261.2 | 111.0 | 372.2 | 47.64 | 1.085 |
| 650 | 343.3 | 58.9 | 73.6 | 267.9 | 109.5 | 377.4 | 47.30 | 1.185 |
| 660 | 348.9 | 65.3 | 80.0 | 274.6 | 108.5 | 383.1 | 46.95 | 1.285 |
| 670 | 354.4 | 72.2 | 86.9 | 281.3 | 107.0 | 388.3 | 46.59 | 1.395 |
| 680 | 360.0 | 79.5 | 94.2 | 288.0 | 105.5 | 393.5 | 46.20 | 1.510 |
| 690 | 365.6 | 87.2 | 101.9 | 294.7 | 104.0 | 398.7 | 45.77 | 1.620 |
| 700 | 371.1 | 95.4 | 110.1 | 301.5 | 103.0 | 404.5 | 45.38 | 1.730 |
| 710 | 376.7 | 104.1 | 118.8 | 308.2 | 102.0 | 410.2 | 44.98 | 1.840 |
| 720 | 382.2 | 113.3 | 128.0 | 315.0 | 100.5 | 415.5 | 44.57 | 1.965 |
| 730 | 387.8 | 122.9 | 137.6 | 321.8 | 99.0 | 420.8 | 44.15 | 2.100 |
| 740 | 393.3 | 133.3 | 148.0 | 328.6 | 98.0 | 426.6 | 43.72 | 2.245 |
| 750 | 398.9 | 143.9 | 158.6 | 335.4 | 96.5 | 431.9 | 43.28 | 2.400 |
| 760 | 404.4 | 155.2 | 169.9 | 342.2 | 96.0 | 438.2 | 42.82 | 2.565 |
| 770 | 410.0 | 167.1 | 181.8 | 349.0 | 95.0 | 444.0 | 42.35 | 2.750 |
| 780 | 415.6 | 179.7 | 194.4 | 355.9 | 94.0 | 449.9 | 41.87 | 2.945 |
| 790 | 421.1 | 193.0 | 207.7 | 362.7 | 93.0 | 445.7 | 41.39 | 3.145 |
| 800 | 426.7 | 207.1 | 221.8 | 369.6 | 91.5 | 461.1 | 40.89 | 3.355 |
| 810 | 432.2 | 221.2 | 235.9 | 376.4 | 90.0 | 466.4 | 40.38 | 3.580 |
| 820 | 437.8 | 236.3 | 251.0 | 383.3 | 88.5 | 471.8 | 39.84 | 3.825 |
| 830 | 443.3 | 252.2 | 266.9 | 390.1 | 86.5 | 476.6 | 39.28 | 4.090 |
| 840 | 448.9 | 268.6 | 283.3 | 397.0 | 85.0 | 482.0 | 38.69 | 4.375 |
| 850 | 454.4 | 286.2 | 300.9 | 403.9 | 82.5 | 486.4 | 38.10 | 4.690 |
| 860 | 460.0 | 304.2 | 318.9 | 410.8 | 80.0 | 490.8 | 37.48 | 5.040 |
| 870 | 465.6 | 323.1 | 337.8 | 417.7 | 77.0 | 494.7 | 36.84 | 5.420 |
| 880 | 471.1 | 342.9 | 357.6 | 424.6 | 74.0 | 498.6 | 36.14 | 5.845 |
| 890 | 476.7 | 363.5 | 378.2 | 431.5 | 71.0 | 502.5 | 35.41 | 6.320 |
| 900 | 482.2 | 385.0 | 399.7 | 438.4 | 67.5 | 505.9 | 34.58 | 6.850 |
| 910 | 487.8 | 407.5 | 422.2 | 445.3 | 64.0 | 509.3 | 33.68 | 7.455 |
| 920 | 493.3 | 430.9 | 445.6 | 452.2 | 59.5 | 511.7 | 32.61 | 8.145 |
| 930 | 498.9 | 455.2 | 469.9 | 459.1 | 53.5 | 513.6 | 31.40 | 8.930 |
| 940 | 504.4 | 480.6 | 495.3 | 466.0 | 47.0 | 513.0 | 29.93 | 10.070 |
| 950 | 510.0 | 506.9 | 521.6 | 473.0 | 39.0 | 512.0 | 28.14 | 11.700 |
| 960 | 515.6 | 534.3 | 549.0 | 479.9 | 29.5 | 509.4 | 26.00 | 13.850 |
| 970 | 521.1 | 562.7 | 577.4 | 486.8 | 19.0 | 505.8 | 23.60 | 16.550 |
| 980 | 526.7 | 592.3 | 607.0 | 493.7 | 0.0 | 493.7 | 19.60 | 19.600 |

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required for furnace-gas reheating. Even at that, the reheat temperature obtained could hardly reach 700 deg. F. Since a reheat temperature of 750 deg. is now normal practice and a general advance to 800 or 850 deg. in the not distant future is possible, the field for critical-pressure steam as a reheating medium is not promising.

There is, therefore, a real need for some heating medium having the necessary saturation temperature at a reasonable pressure, and having certain other desirable physical and chemical properties. The substance "diphenyl" ($C_6H_5$—$C_6H_5$) gives every promise of being this material. A few years ago it was merely a chemical curiosity too high in price for general commercial use. It is now obtainable at 30c. per pound in carload lots in commercial or technical grades.

Studies of diphenyl made some years ago indicated that its properties would be of great value in heat-transfer work. Since then it has undergone extensive testing under commercial conditions in the oil refining industry.

### Diphenyl Has Been Used for Two Years in Oil-Refining Process

Diphenyl has been in use now for more than two years by the Indian Refining Company at Lawrenceville, Ill., as an indirect heating medium in the distillation of Govers process wax-free Havoline lubricating oil. This unit is of about 15,000,000 B.t.u. per hr. capacity, and it has definitely proved that the use of diphenyl as an indirect heating medium is practical, and that this compound is stable and non-corrosive.

The table (in skeleton form) on the preceding page gives the physical properties of diphenyl. In addition to the information therein contained it may be well to mention here diphenyl's principal characteristics:

| | |
|---|---|
| Melting point, deg. F | 156.6 |
| Boiling point at 14.7 lb. abs. pressure, deg. F | 491.5 |
| Critical temperature, deg. F | 980 |
| Critical pressure, lb. per sq.in. gage | 592.3 |

It is usually desirable to compare a new product with one that is well known. Of course, steam should be the product to compare diphenyl with, but as the pressure of saturated steam is about 620 lb. gage at the boiling point of diphenyl, it is almost impossible to make a comparison if it is desired to do justice to both materials. In other words, diphenyl does not really enter the picture as an indirect heating medium until the pressure of saturated steam, at the temperature desired, becomes excessive Also, a comparison between diphenyl and superheated steam does not correctly portray the conditions, because superheated steam can give up but little of its heat in the superheat range and for that reason does not find application as a heating medium except in isolated cases. It is well to add at this time that diphenyl vapor is very dense when compared to steam at the same pressure.

As this discussion, because of its brevity, could not possibly go into detail, only the high points will be touched. A simple example will be used: Suppose we assume that a 100,000-kw. cross-compound turbine-alternator is to be installed and that the high-pressure unit is to exhaust at 360 lb. gage. We shall concern ourselves only with the selection of the method to be employed in reheating.

Only a few figures in round numbers will be used here. Let us first assume that the turbine will have a steam rate of 10 lb. per kilowatt-hour. This will make the maximum quantity of steam to be reheated 1,000,000 lb. per hour. To reheat 1 lb. of saturated steam at 360 lb. pressure to 750 deg. F. 188 B.t.u. will be required, giving a total heat supply of 188,000,000 B.t.u. per hour.

If we used saturated diphenyl vapor at 800 deg. (207.1 lb. gage) and utilized only the heat of vaporization (91.5 B.t.u. per lb.) we should require about 2,250,000 lb. of diphenyl vapor per hour, taking into consideration the usual losses involved in an operation of this kind. Allowing for a pressure drop of 2.3 lb. per 100 ft. of pipe length, a 20-in. pipe would be required. As we are primarily concerned with the heat content of the diphenyl, it would not be serious if we increased this pressure drop slightly by using a smaller pipe.

In the design of the heat exchanger proper there are many questions that will have to be taken into consideration and will have to be determined largely by the equipment manufacturer. Because of the lower pressure of the diphenyl it might be advisable to put the diphenyl outside the tubes and the steam inside. On the other hand, if this were reversed the superheated steam, which has the lower heat transfer coefficient, could be put in contact with finned tubes, thereby decreasing the over-all size of the reheater.

On the discharge side of the heater the quantity of liquid diphenyl to be handled would approximate 7,000 gal. per minute. To maintain a liquid velocity of 7.2 ft. per second a 20-in. pipe line would be required. A pump of the same capacity would be needed to return the condensate to the boiler.

In the construction of the diphenyl boiler another consideration, not usually encountered, is met. To prevent decomposition at excessively high temperatures, it would be advisable to provide mechanical circulation. The fact that the furnace may develop hot spots of varying location makes this precaution doubly necessary. It is therefore suggested that a quantity of diphenyl in excess of the quantity vaporized be passed through the tubes, and that the part not carried off as a vapor be recirculated.

It will also be necessary to determine whether the diphenyl will be heated in a separate boiler or in a diphenyl section of a regular steam boiler. The size of the unit to be installed will largely determine this.

In considering a problem of this kind numerous points come up for discussion that would effect the general over-all efficiency of the reheat cycle. For instance, it might be advisable to expand the diphenyl during its passage through the heater to a lower pressure, thereby lowering the discharge temperature of the liquid considerably below 800 deg. F., getting additional heat out of each pound of material, and decreasing the quantity of diphenyl to be handled. One way to accomplish this would be to use two heaters in series with a throttling valve between, the steam passing first through the low-pressure heater and then through the high. Tightness is of primary importance in any system using diphenyl as an indirect heating medium. Make-up should be low, generally less than 1 per cent monthly.

### Welded Piping Is Preferred

Oxy-acetylene welding is recommended where practical, but flanged joints will give satisfactory results with a good grade of high-temperature packing. Also, screwed pipe in small sizes can be employed, but the thread should be cut or retraced with new taps and dies to insure a tight fit. If a leak develops at a point in the system where an open flame is present, diphenyl will burn. However, when no open flame is present it will

condense, freeze, and fall to the floor as a crystalline solid. As diphenyl has an aromatic odor, leaks can be detected easily.

### Summary of Diphenyl's Advantages

In considering diphenyl for indirect reheating, its principal advantage in each case will be found to be as follows:

1. By replacing steam in an indirectly heated reheater a considerably higher reheat temperature may be obtained without excessive pressure, thereby decreasing the steam rate on the turbine. A comparison of two similar stations, one using diphenyl and reheating to 750 deg. F. and the other steam and reheating to 550 deg., was recently made, and the higher reheat justified an additional expenditure of $2.50 per kilowatt of capacity, whereas the actual additional expenditure was estimated to be not in excess of $1 per kilowatt. In quoting the foregoing figures it should be added that the calculations were of a very preliminary nature and would not necessarily hold for any other installation.

2. When replacing a direct-fired reheater the first advantage that comes to mind is that of decreasing the pressure drop between the high- and low-pressure turbines. In addition, more accurate control of the reheat temperature is possible. Because of the quantity of diphenyl to be handled it would at first appear that the pipe sizes would be excessive. Actually, diphenyl vapor at 800 deg. has a density of 3.355 lb. per cubic foot, whereas saturated steam at 360 lb. pressure (the pressure at the discharge of the high-pressure turbine in this assumption) has a density of 0.805 lb. per cubic foot, so that the pipe size would be practically the same.

The whole question of using diphenyl or some other substance as an indirect heating medium to replace the methods now in use depends upon its qualification from an engineering and economic point of view. In other words, can it justify its adoption in this field? The answer appears to be "yes."

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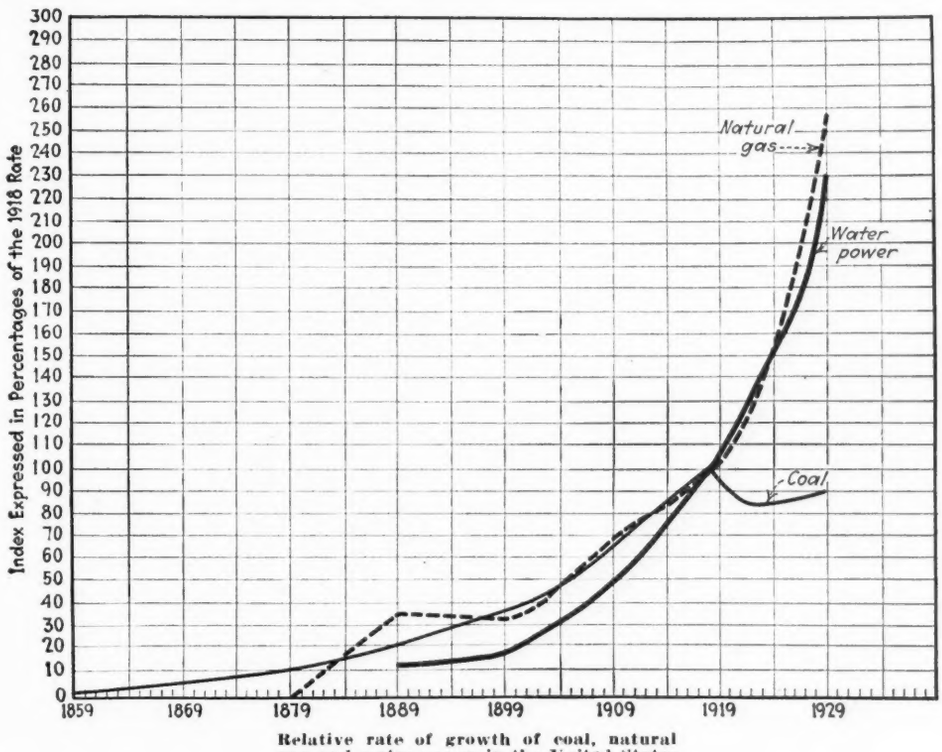
# Growth of Energy Sources in the United States

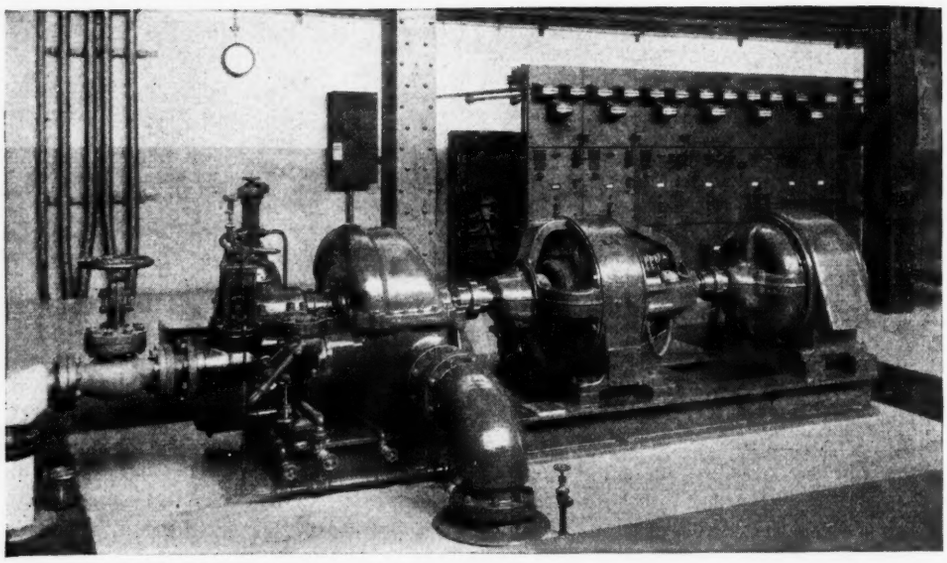
BITUMINOUS COAL remained the principal source of energy supply of the United States in 1929, according to a special study by F. G. Tryon of the Bureau of Mines. Coal production in 1929, although higher than in 1928 and 1927, fell considerably short of the war-time maximum, while the production of oil, natural gas, and water power has increased enormously since the war.

An interesting deduction from Mr. Tryon's data is the fact that the total requirements of energy in the raw state, as expressed by the volumes of fuels and water power used, have changed little during the past decade when computed upon a per capita basis. In years of business activity, they increase slightly; in years of recession they drop off slightly. In 1920, a year of unusual industrial production, the total energy supply was approximately 211 million equivalent B.t.u. per capita; in 1929, also a year of great activity, it was 218 millions. The intervening years show a decline to 169 millions during the depression of 1921, with a rise to a high point of 220 millions with the recovery in 1923.

While the grand total of raw material upon a population basis remains about the same, the efficiency of its use, has however, steadily improved, and there has also been a decided shift from one source of power to another. Both kinds of coal show a steady decline since 1918 especially anthracite, while the use of water power and gas show very marked increases, as indicated in the accompanying chart.




**Relative rate of growth of coal, natural gas and water power in the United States**



Turbine-induction motor-generator of 75 kw. output for direct-current excitation in a pulp and paper plant

# *Industrial Applications of MOTOR-GENERATORS*

**By E. C. DIEFFENBACH**
*Industrial Engineering Department*
*General Electric Company*

**Motor-generator sets have become one of the power-application engineer's most useful tools. They provide methods of control otherwise impossible for wide-range speed adjustment, and for reversing and precision drives**

MOTOR-GENERATORS are used where applications have characteristics that cannot be met by the available power supply. A motor suited to the power supply is used to drive one or more generators having the desired characteristics. Motor-generators have become important tools for the conversion and adaptation of the power supply to the needs of applications. They are important links between the power supply and the equipment that uses it, and have no substitute for certain kinds of work.

Motor-generators make any conversion that rectifiers, synchronous converters, or transformers can, and many which they cannot, accomplish. They provide methods of control otherwise impossible for wide-range speed adjustment, reversing, and precision motor drives.

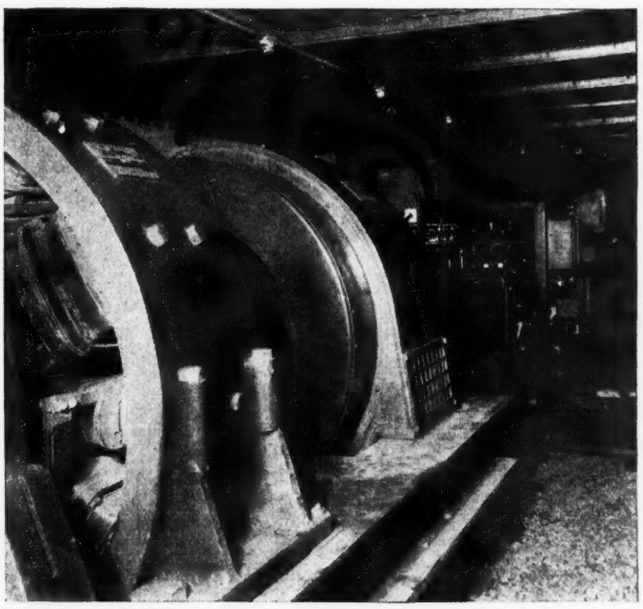
The wide diversity of uses for motor-generators other than for generator-voltage (Ward Leonard) control applications may be better understood by examining the following list. The tabulation is in no way complete and lists only the principal uses, many of which are subject to variations to suit specific applications in industry.

1. Constant direct-current voltage from alternating- or direct-current supply:
   - (*a*) Adjustable-speed motors on machine tools, feeding devices, material-handling equipment, and process machines.
   - (*b*) Excitation for alternating-current generators, synchronous motors and synchronous condensers. Excitation for direct-current generators and motors used with generator-voltage control systems.
   - (*c*) Battery charging.
   - (*d*) Electrolytic work.
   - (*e*) Solenoid brakes on alternating-current motors.
   - (*f*) Constant-potential arc welding.
   - (*g*) Balancing 3-wire direct-current systems.
2. Variable direct-current voltage from alternating-current or direct-current supply:
   - (*a*) Arc welding (single-operator).
3. Adjustable direct-current voltage from alternating-current or direct-current supply:
   - (*a*) Generator-voltage control for motors.
   - (*b*) Variable excitation for generators of large generator-voltage control units.
4. High or low alternating-current frequency from alternating-current or direct-current supply:
   - (*a*) High-speed motors on machine tools and wood-working machinery.
   - (*b*) To simplify gearing for low-speed drives.
   - (*c*) Signal circuits to avoid interference from transmission lines.
5. Adjustable alternating-current frequency from direct-current supply:
   - (*a*) Unit speed control of a group of alternating-current motors.

6. Change the number of phases from an alternating-current supply:
   (*a*) Signal power supply for railways.
   (*b*) Single-phase power supply.
7. Sine-wave alternating-current power from alternating-current or direct-current supply:
   (*a*) Testing.
   (*b*) Educational purposes.

The ease of transforming alternating current has made its use almost universal, yet for many applications direct current is preferable or necessary. For many kinds of work, such as electrolytic processes and battery charging, direct current must be used. Since practically all power generated and distributed in large blocks is alternating current, each direct-current application requires a motor-generator or other form of conversion apparatus.

General practice has placed direct-current generator voltages at 125, 250 or 275, and 500 volts. Alternating-current motor voltages on motor-generator sets under 25 kw. are usually 220, 440, or 550 volts. Small-size induction motors are not wound for higher voltages, because of insulation difficulties. For motor-generators above 25 kw., 2,300-volt motors are available. The speeds range from 1,800 r.p.m. for the smaller sizes to 900 r.p.m. for the larger units. Manufacturers have established standard lines of motor-generators having ratings approximately as follows: Synchronous-motor drive, 50 to 300 kw.; induction-motor drive, 1 to 150 kw. Special sets can always be obtained, and in much larger ratings.



Motor-generators of over 100 kw. output are usually driven by synchronous motors. The speed of synchronous motors is constant, and the cost of the larger sizes is lower than that of the induction motor. Synchronous motors have the important advantage of, when over-excited, acting as synchronous condensers, and may be utilized to improve a system's power factor. Synchronous motors operate at a constant speed when the frequency is constant. When they drive direct-current generators the voltage of the generators can be maintained constant, so far as speed can do it, at all loads. This speed is independent of alternating-current voltage fluctuations and regardless of the motor-generator's distance from the power-supply station.

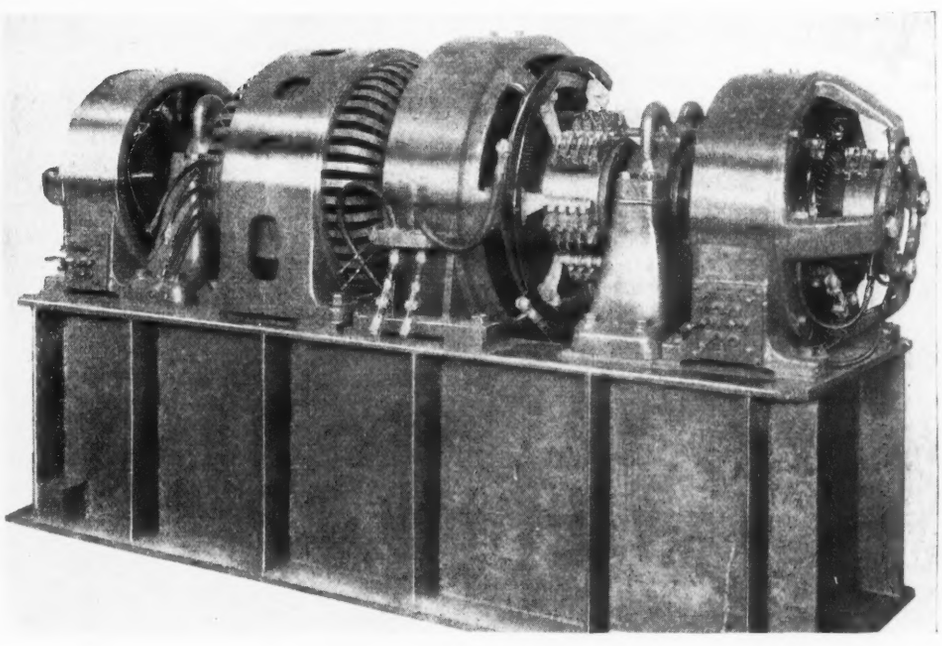
The power factor of a system should be as high as consistently possible with other considerations. If everything has been done to improve the power factor with properly selected induction motors, and the results are still unsatisfactory, synchronous motors usually serve to effect the desired improvement, other conditions allowing their use.

A motor-generator is often utilized to change the voltage of a direct-current supply. A machine shop load may require a multi-voltage system for obtaining wide speed range; arc-welding electrolytic or electro-chemical work, with its heavy current demand, or the balancing of a three-wire system, may be the problem at hand. Speed and torque regulation by generator voltage control comes under this form of conversion when the source of power supply is direct current.

Although alternating current has largely displaced direct current as a source of electric energy, sometimes the latter is the only power source. In a situation of that kind, where a small amount of alternating current is required, the remedy is to install a motor-generator. The high-frequency alternating current required by motors

**PORTABLE 300-KW. SYNCHRONOUS MOTOR-GENERATOR AND AUTOMATIC-SWITCHING EQUIPMENT INSTALLED IN A COAL MINE**

This portable substation is advanced as required to keep it near the center of the direct-current load.

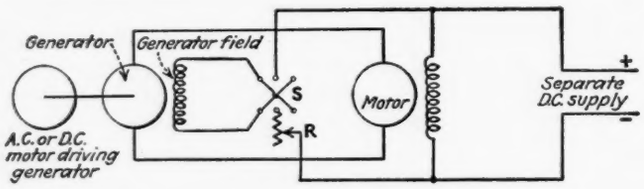


**POWER-SHOVEL MOTOR-GENERATOR CONSISTING OF A SYNCHRONOUS MOTOR AND THREE GENERATORS**

The length of the set is limited by the width of the shovel cab, hence only two bearings are used. Each generator drives one of the shovel-motion motors under generator-voltage control.

driving tools at high speeds may readily be produced in this way. With a direct-current supply, the speed of the motor driving the alternating-current generator may be changed, thus changing the frequency of the output and with it the speeds of all connected alternating-current motors.

One of the chief reasons for the popularity of direct-current drive in industry today is the ease with which motors' speeds and directions of rotation are controlled with what is known as generator-voltage, generator-field, or Ward Leonard control. Motor-generators make possible the host of industrial applications using them. This




ELEMENTARY CONNECTION DIAGRAM OF GENERATOR-VOLTAGE (WARD LEONARD) SYSTEM OF CONTROL

method of control requires a separate generator for each motor or for each group of motors manipulated as one. In addition, a motor is required to drive each generator, unless several generators can be grouped on a common base with a single large driving motor. The remarkable characteristics of this control, which can be obtained in no other way, accounts for the continued and increasing use of direct-current motors in the face of an almost universal alternating-current supply.

Some of the advantages of generator-voltage control are:

1. Speed adjustment from zero to the maximum motor speed.
2. Motor may be almost instantly reversed without shock to connected mechanism.
3. Adjusting speed and reversing are accomplished through manipulation of field currents of the direct-current generator.
4. Simplicity and effectiveness of applying dynamic braking to the motor.
5. Ease with which a system may be made self-protecting against overloads by means of differential series field on the generator.
6. Its use, where its characteristics are of most value, results in increased output with lower maintenance cost than is possible with any other drive.

The diagram of a Ward Leonard control, in one of its simplest forms, shows how the motor's field is excited from a separate source of direct current. The generator's field is excited in a similar way, except that its circuit contains a reversing switch *S* and a field rheostat *R*. The generator's armature is electrically connected to the armature of the motor. By means of the reversing switch *S* and the rheostat *R* the voltage supplied to the armature of the main motor is reversed and adjusted.

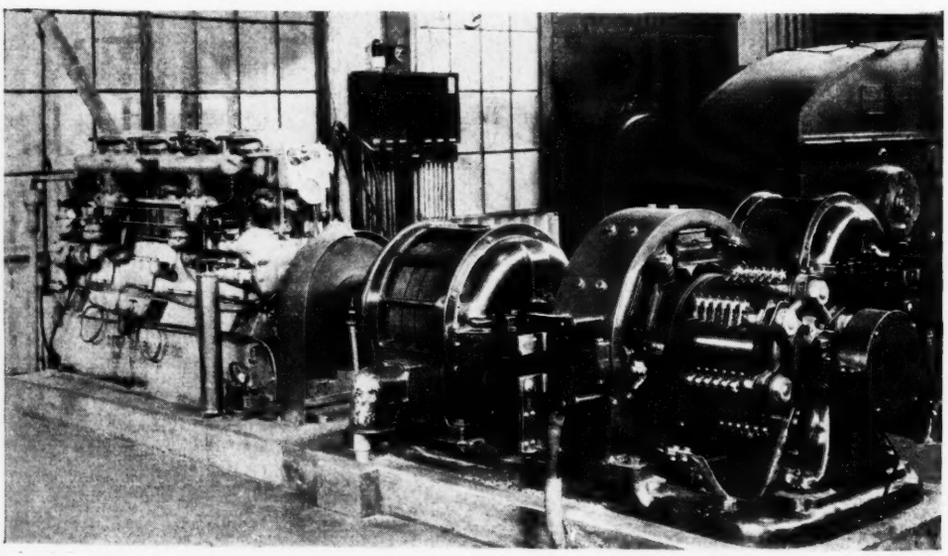
Since the generator's output may be varied from zero to maximum in either polarity, the speed of the driven motor will follow the voltage, and its direction of rotation will agree with the polarity of the generator. This control is accomplished through the adjustment of the relatively small generator field current. For large units the field of the generator exciter is controlled to attain this end, and currents of comparatively small values are varied to control the large outputs.

Modifications of the elementary Ward Leonard system are used in steel mill main roll drives and auxiliaries, vertical-lift bridges, high-speed elevators, heavy-duty freight elevators, paper machines, load regulators for pulp grinders, rewinders on paper machines, car dumpers and their mule hauls, stokers, cable-stranding machines, power shovels and draglines, mine hoists, blast furnace skip hoists, dredges, automatic car washers, printing presses, dynamometer testing equipment, and specialties.

Steel mill or metal mill work requires good speed control and flexibility when starting and reversing. The motor-generator with the modified Ward Leonard connections supplies this type of drive from any kind of power supply. This system controls large torques and wide speed variations without enormous circuit breakers in the motor armature circuit; it also assures steady and satisfactory operation without using large, wasteful resistance grids.

Starting, simultaneous, and proportional speed adjustment of several direct-current motors are desirable for some kinds of work. The stands on a continuous mill illustrate an outstanding example of this kind of control; if each one is connected to an individual motor the entire group can be slowed down or speeded up as a unit or each individual stand can be adjusted to the desired speed.

Motor-generators are in wide use for converting the voltage and current of commercial power supply lines to



GASOLINE ENGINE SYNCHRONOUS MOTOR-GENERATOR SET FOR EXCITATION AND DIRECT-CURRENT POWER AT A CEMENT PLANT

In case of power failure, the engine is started and furnishes sufficient power to keep the kilns running to prevent distortion due to localized heat.

direct-current at low voltage and high current with drooping characteristics as required for arc-welding.

Extensive use and research have established common practice in the arc-welding industry. Good welding can be done with direct-current values ranging up to 300 and even 500 amp. Open-circuit voltages of 60 to 90 volts are required for single-operator sets, and these machines automatically drop their voltage to 20 or 25 volts as soon as the arc is struck. Single-operator sets are built in sizes from 100 to 400 amp. capacity.

With the multiple-operator welding units, the open-circuit voltage is always 60 volts, and these sets are built to maintain the same value of voltage both at open circuit and at full load. Resistors are used with these sets to reduce the voltage for each operator to the 20 or 25 volts required for the arc. Multiple-operator arc-welding motor-generator sets are built in sizes ranging from 400 to 2,500 amp., supplying welding current simultaneously to from 3 to as many as 25 operators.

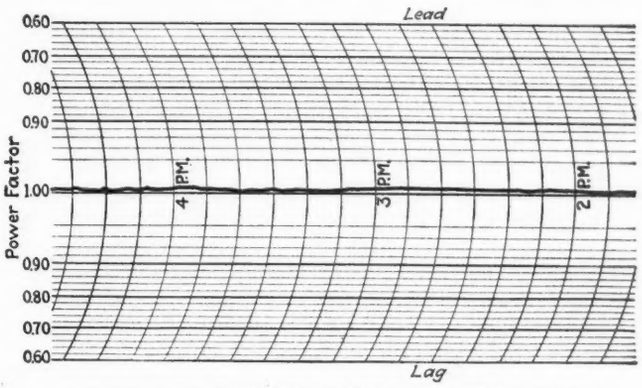
The heavy welding current can be produced with a minimum of attention and maintenance. Welding equipment is subject to heavy duty; hence the strength and reliability built into its component parts are of special importance. Designers and engineers have learned to build motor-generators on arc-welding machines to produce the necessary electrical characteristics for welding, the individual parts having mechanical construction to withstand severe service.

The power contract of one manufacturer necessitated a plant power factor at or near unity if maximum operating economy was to prevail. Although there was enough synchronous motor power in the plant to give ample power factor improvement at certain times of the day, there were times when the plant demand had to be maintained at a low figure to take advantage of a favorable contract price for power. At such times the load would consist largely of induction motors, and the plant power factor would fall far below unity. This difficulty was met by developing a power factor control mechanism which continuously functioned automatically to adjust the excitation of a 750-kva. synchronous motor of a motor-generator. The adjustment was made so that exactly the proper amount of corrective kilovolt-amperes was furnished at all times by the machine to make the over-all power factor of the plant unity.

In addition to improving the plant's power factor, this motor-generator supplies direct current for synchronous motor excitation and for direct-current adjustable-speed motors. The curve shows how constant the control mechanism maintained the power factor at an average value of unity, never permitting a wide deviation.

Motor-generators with direct-connected steam turbines are frequently used as power station auxiliary equipment. The motor normally drives the set, with the turbine idling under steam. Such sets are used for excitation. Should power fail on the motor side, a slight drop in speed puts the turbine on the speed governor and the generator is kept running. The turbine also provides a source of excitation current when the station is being started.

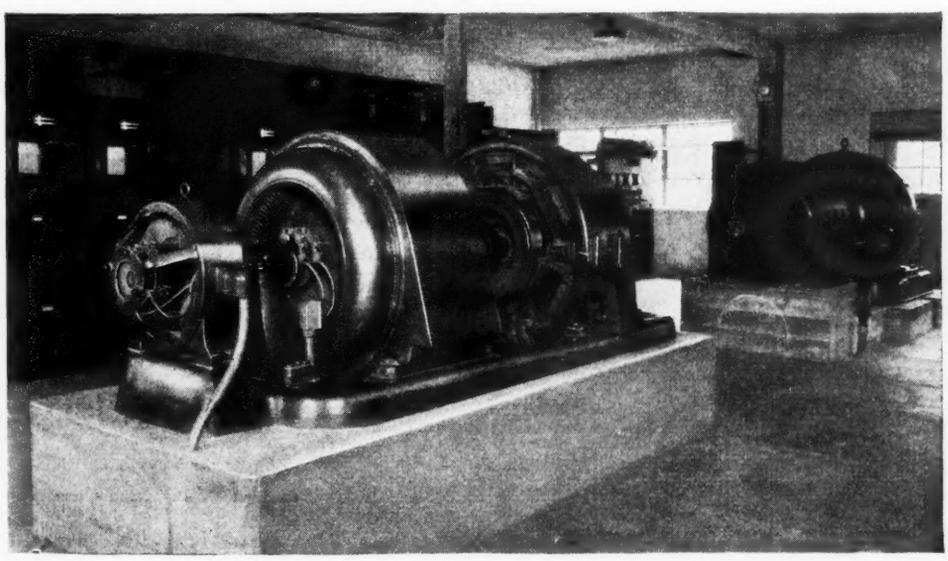
A special application of a dual-drive motor-generator is found in an Eastern paper mill. The Fourdrinier




**SECTION OF RECORDING POWER-FACTOR METER CHART**

Curve shows that the power factor was maintained at unity by the automatic control mechanism; maximum deviation only four-tenths of 1 per cent despite considerable variation in power demand.

paper machine has a single-motor drive, current for which comes from a dual-drive set. The paper made is so thin that the turbine exhaust furnishes steam enough for drying the paper when it is carrying only half load. The other half of the required power is furnished by the synchronous motor in the other end of the set. In case lightning interferes with the electric power line, the whole load is automatically transferred to the turbine and its excess exhaust steam is bypassed to other parts of the mill. A momentary shutdown of the paper machines would require a wash-up and hours of lost time. With this dual drive the machine tenders cannot detect the changeover, and, as the mill is located where lightning disturbances are frequent, the arrangement saves much time that would otherwise be lost.



**SYNCHRONOUS - MOTOR GENERATOR SET IN THE SWITCHBOARD ROOM OF A LIME AND CEMENT PLANT**

By using an ingenious automatic power-factor control system, the over-all plant power factor is maintained at or near unity by varying the excitation on the 435-hp. synchrononus motor. The generator is rated 300 kw. at 250 volts.

# Design Features of the Niederwartha Pumping Units

By ELY C. HUTCHINSON
*Editor of* POWER

ALTHOUGH the stored water power and pumping system at the Niederwartha plant of the Saxon Public Works, Inc., of Germany has been broadly described in the July 22 number of *Power* and in other technical journals, the author considers the hydraulic design features of the installation to be more interesting than in most of the plants inspected during his recent visit to Europe.

The project is the largest of its kind to date and was installed to improve the load factor of the existing brown coal steam plants, notably those of Boehlen and Hirschfelde, both of which have excess capacity during off-peak periods. This surplus capacity is used to pump water from a lower storage reservoir to an upper reservoir where it is held as potential power for service during the daily periods of short, peak power demand. The economics of an installation of this sort, present an interesting study and, from the author's observations, it is doubtful whether the scheme will ever have widespread use in the United States.[1] In fact, the Saxon Public Works, Inc., freely admits that the Niederwartha plant is made possible only through the ability of the existing steam plants to generate current at extremely low cost from their open-cut brown coal supplies.

The plant, a short distance from Dresden, is approximately midway between the Boehlen and Hirschfelde plants. The lower storage reservoir, or afterbay, is approximately 2,500 ft. from the River Elbe and, when filled to ultimate capacity, will hold 1,540 acre-feet of water at an elevation approximately 25 ft. above the mean river surface. A flood record established 40 years ago indicates that a repetition would inundate the power house and reservoir to a level about 5.25 ft. below the high water surface. Consequently, steel sheet piling incloses the entire project at all points where there would be danger of water infiltration. The initial water supply, for the operation of the plant, is pumped from the River Elbe. Since starting up, the middle of December, 1929, the flow from a small near-by mountain stream has furnished all the make-up water necessary to compensate for evaporation and to provide cooling water for the transformer oil.

The upper reservoir, or forebay, is of the same capacity as the lower, although it differs in change of water levels for similar water volumes. The reservoirs are joined, at present, with two steel pipes, each approximately 6,300 ft. long and having diameters varying from 11.5 to 8.25 ft. Each pipe is connected to two hydro-electric, combined generating and pumping units, there being four such units installed at the present time to provide one-half of the ultimate capacity of the project. At the junction between the flow line and penstock sections of each pipe a plate-steel surge tank of 55 ft. diameter and 115 ft. height is provided. The extreme differences in the elevations of water surfaces between the two reservoirs are as follows:

CASE No. 1—Forebay full and afterbay empty—490.5 ft.
CASE No. 2—Forebay empty and afterbay full—445.0 ft.

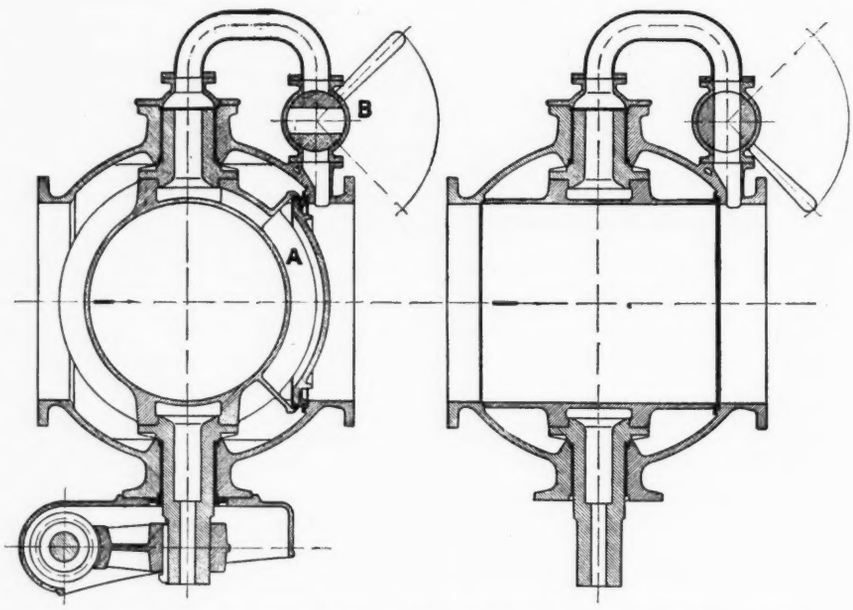



**Fig. 1—Shut-off valve (left closed, right open) for pumps and turbines. Before opening, valve disk *A* floats as pressure is counterbalanced through bypass *B***

Design data for each of the four turbines are:

| | Case No. 1 | Case No. 2 |
|---|---|---|
| Net effective head, ft. | 470 | 398 |
| Water quantity, cu.ft. per sec. | 653 | 600 |
| Capacity in horsepower | 30,330 | 23,400 |
| Approx. turbine efficiency, per cent | 86 | 86.9 |
| R.p.m. (normal) | 375 | 375 |
| R.p.m. (runaway) | 710 | 710 |

Best efficiency of turbines at some point between Case No. 1 and Case No. 2 is 90 per cent.

The pumps operate over the same range of head differences as the turbines except, of course, that pipe friction must be added.

Design data for each of the four pumps are:

| | Case No. 1 | Case. No. 2 |
|---|---|---|
| Amount water pumped, gal. per sec. | 2,500 | 3,135 |
| Total pumping head, ft. | 506 | 455 |
| Horsepower input to pump | 23,800 | 27,000 |
| Approx. pump efficiency, per cent | 80 | 80 |
| R.p.m. | 375 | 375 |

Best efficiency at some point between Case No. 1 and Case No. 2 is 82 per cent.

The power house is well arranged, with the four units

[1] The only plant of this type in the United States is the Rocky River development on the Housatonic River in Connecticut, for a description of which see *Power*, Dec. 24, 1929.

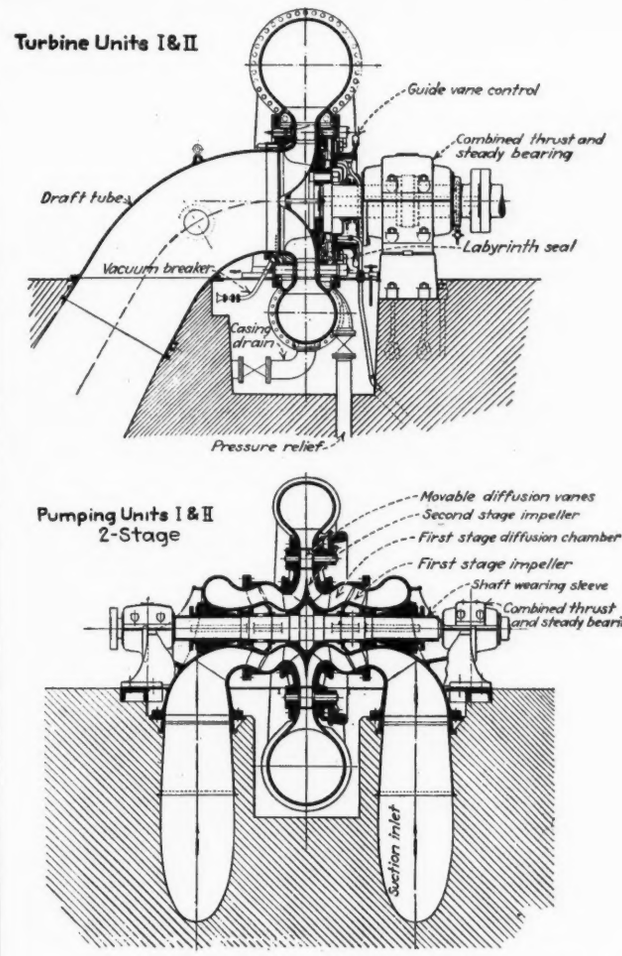



**Fig. 2—Escher-Wyss designs for hydraulic turbines and two-stage pumps**

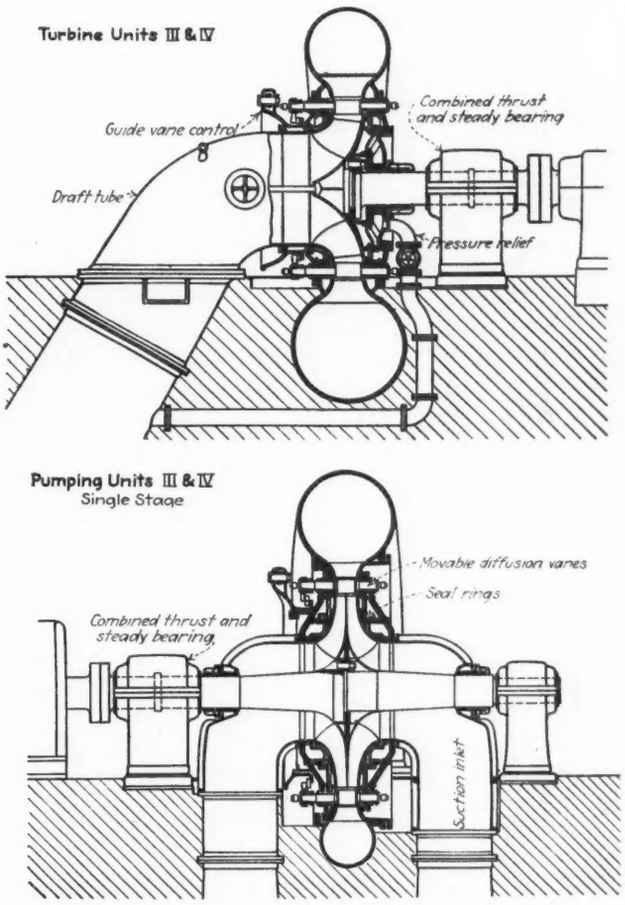



**Fig. 3—Single-discharge turbines and single-stage pumps as supplied by Voith-Sulzer**

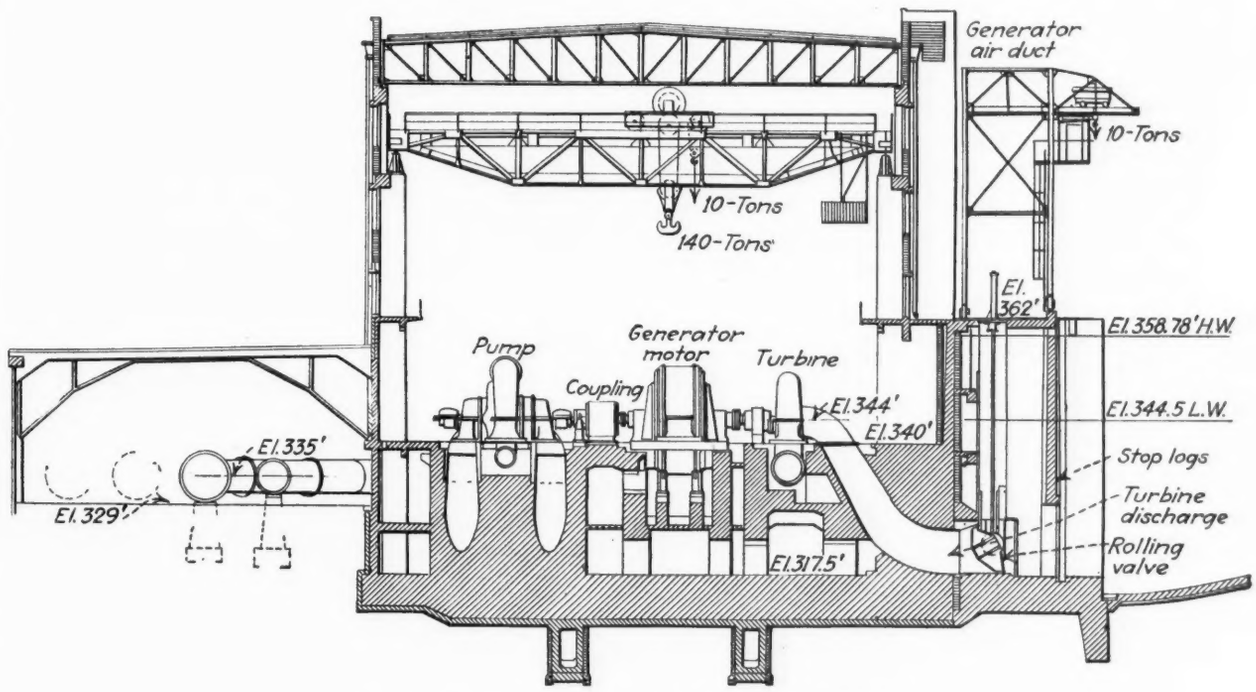
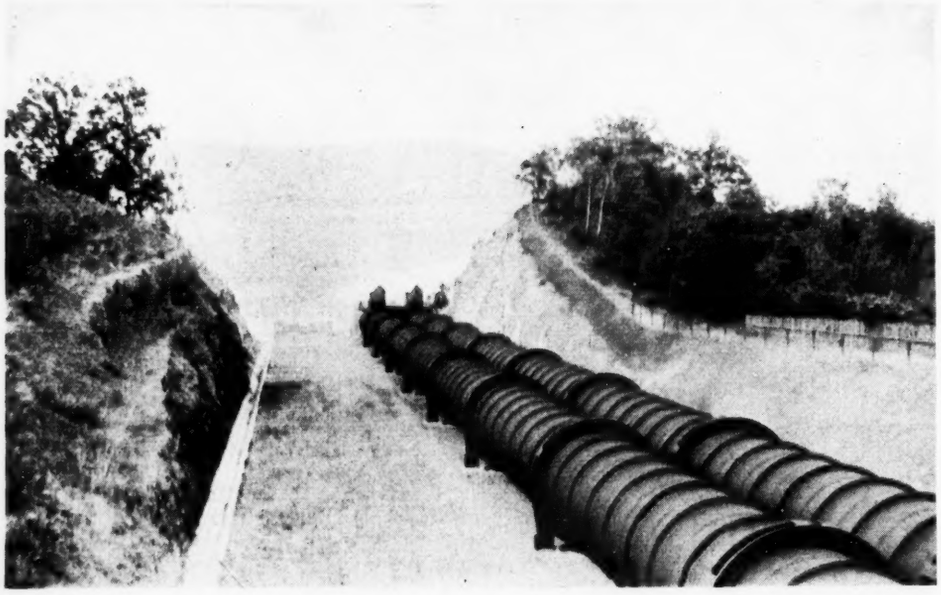



**Fig. 4—Cross-sectional view through power house, showing general setting of turbine, pumps and generator motor**



**Niederwartha penstocks for units 1, 2, 3, and 4, looking in same direction as the water flow. Space to the left is excavated for installation of the two future pipes**

having their axes parallel and at right angles to the major axis of the building. The arrangement is shown in Fig. 4. It will be seen that the hydraulic turbine and the generator motor are rigidly coupled, while an oil-pressure-operated, cone-type friction coupling makes it possible to disconnect the pumps completely when the units are generating power. It will also be seen that the power house floor level is well below the level of high water in the afterbay, for which reason the wall construction is made heavier and water tight.

Pumps and turbines for two units were furnished by the Escher Wyss Company of Zurich, while, for the remaining two, the turbines were built by the Voith Manufacturing Company of Heidenheim, and the pumps are of Voith-Sulzer construction.

Although constructed for identical operating conditions, the pumps and turbines of the two companies vary decidedly in design. Figs. 2 and 3, showing the construction furnished by the respective builders, will give a good idea of these differences.

Considering the turbine designs first, it will be noticed that turbines 1 and 2 have their gate-operating mechanism away from the draft tube and next to the combined thrust-and-steady bearing.

It is considered better practice to avoid this, if possible. The design of turbines 3 and 4 shows an arrangement of guide-vane control on the draft-tube side.

Both designs have drain outlets on the inboard side of the runner to relieve pressure and minimize the thrust bearing load. To reduce the power required to rotate the turbine runner when the generator motor is driving the pump, turbines 1 and 2 have vacuum breakers. This should prove useful, because it is necessary to allow a slight leakage of water through the turbine when the pump is in operation. Seal rings for units 1 and 2 are the labyrinth type; while 3 and 4 are the usual straight surface, concentric-ring type having radial clearance. The governors are of the oil-pressure type having belt-driven flyballs and auxiliary hand controls.

The pumps differ radically in design. Those for units 1 and 2 are double-suction, two-stage, with a single double-suction, high-pressure impeller mounted centrally on the shaft and flanked on each side with a low-pressure, single-suction impeller. These impellers have Francis-type, open-end vanes which rotate neatly inside stationary bowls placed between the suction elbows and pump casing covers. Pumps 3 and 4 are of the normal, double-suction single-discharge form, with suction elbows also of a simpler design. No information was available as to the relative efficiencies of the pumps, but both were said to be, to all intents and purposes, the same. It was possible to inspect one of the first-stage runners of units 1 and 2 while the unit was not in operation, and after it had been run daily during the periods necessary for the plant operation.

While the equipment has been in service since the middle of December, 1929, it should not be forgotten that it has been used only a few hours daily. The paint was still on most of the impeller surface, but pitting was plainly visible in spots. There was no opportunity to compare this condition with the vanes on any of the other pump runners.

A small 750-hp. auxiliary vertical-shaft turbine with generator motor and pump provides for the first filling of the pipe lines with water from the afterbay. None other than this first priming has been necessary, since water from the forebay is readily admitted to the pipes preparatory to pumping, provided that they are not already filled from use with the hydraulic turbine.

Safety to the water supply in the forebay is nicely assured by the use of movable guide or diffusion vanes surrounding the pump impeller discharge into the casing. These guide vanes are arranged for automatic closure under any emergency condition. In addition, their movable feature is of great value in maintaining the highest possible discharge efficiency from the impellers under the conditions of variable head and water quantity.

The piping arrangements and connections between turbines, pumps, and the main water lines are a considerable improvement upon many of the other hydraulic stations. There is, however, still plenty of room for the introduction of simpler and more direct systems of water flow in many of the European plants.

The main stop valves used for switching the water connections between pumps and turbines are of the Escher Wyss rotary type, with smooth-bore flow when in open position. This valve design, fairly well known in the United States, is shown in Fig. 1.

The plant has functioned perfectly since installation, and there is no doubt of its technical success.

# Boiler Capacity Doubled

## Without Increasing Space

***New 700,000-lb. unit at Kipps Bay station typifies progress of the last four years***

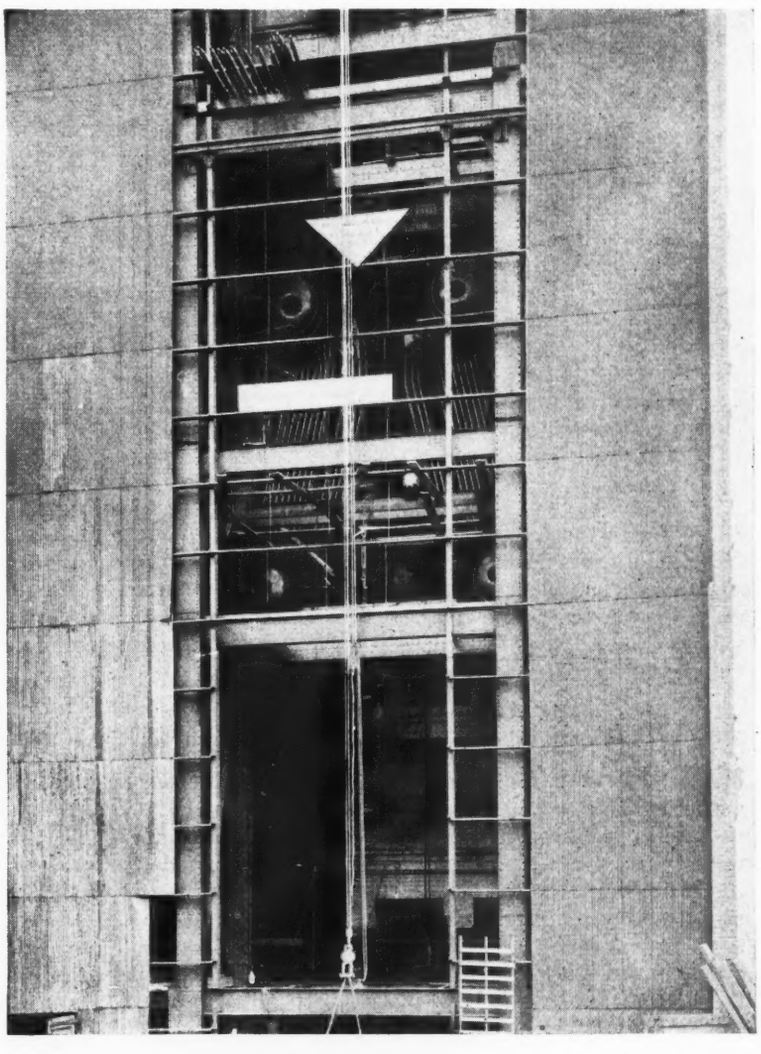
THE STEAM LOAD of the New York Steam Corporation has increased at the rate of about 26 per cent during the last year. During the 1930 season about 10 billion pounds of steam was delivered to its customers. Many new office buildings, ranging from 50 to 85 stories in height, nearing completion, and requiring street steam service, are expected to increase the load for 1931 to such an extent that additional steam-generating capacity will be necessary. As the major part of the additional steam load is within a mile of the Kips Bay station, it was decided to install the needed capacity there.

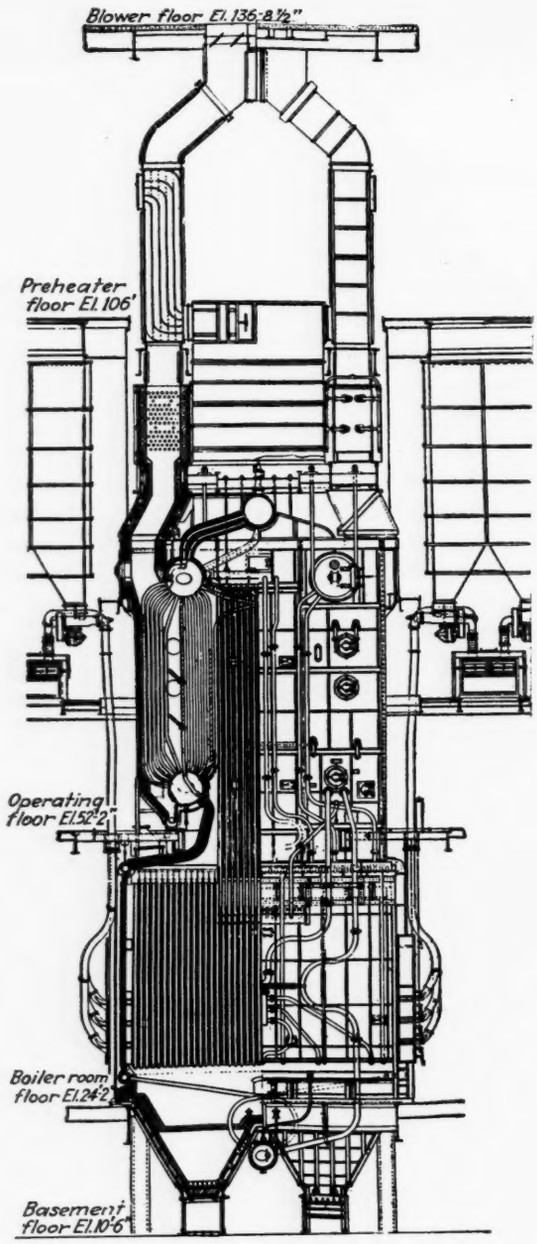
This plant is the most recent station of the New York Steam Corporation, and went into service in 1926 with three boilers of 325,000 lb. per hour capacity. The plant building erected at that time was designed to house six boilers of this size, arranged for vertical firing of pulverized coal. The boilers are of the fire-drum, Ladd type, equipped with water walls, slag screens, economizers, and air preheaters. They generate steam at 275 lb. pressure. During the summer of 1927 a fourth boiler was installed of practically the same general design as the first three units. Vertical firing, however, was discarded for tangential firing, three burners being placed at each corner of the boiler and directed toward the center tangent to a circle. This change permitted operation at higher rating, and evaporation rates of 450,000 lb. per hour have been easily maintained.

At the time this boiler was installed considerable satisfaction was felt because of the increased steam-generating capacity secured from the same building floor space. The boiler that is now being erected outdoes this previous achievement, and is guaranteed to evaporate 700,000 lb. of steam per hour. Both the engineers of the New York Steam Corporation and the boiler manufacturers feel confident that the new unit will be capable of generating at least 900,000 pounds of steam per hour.

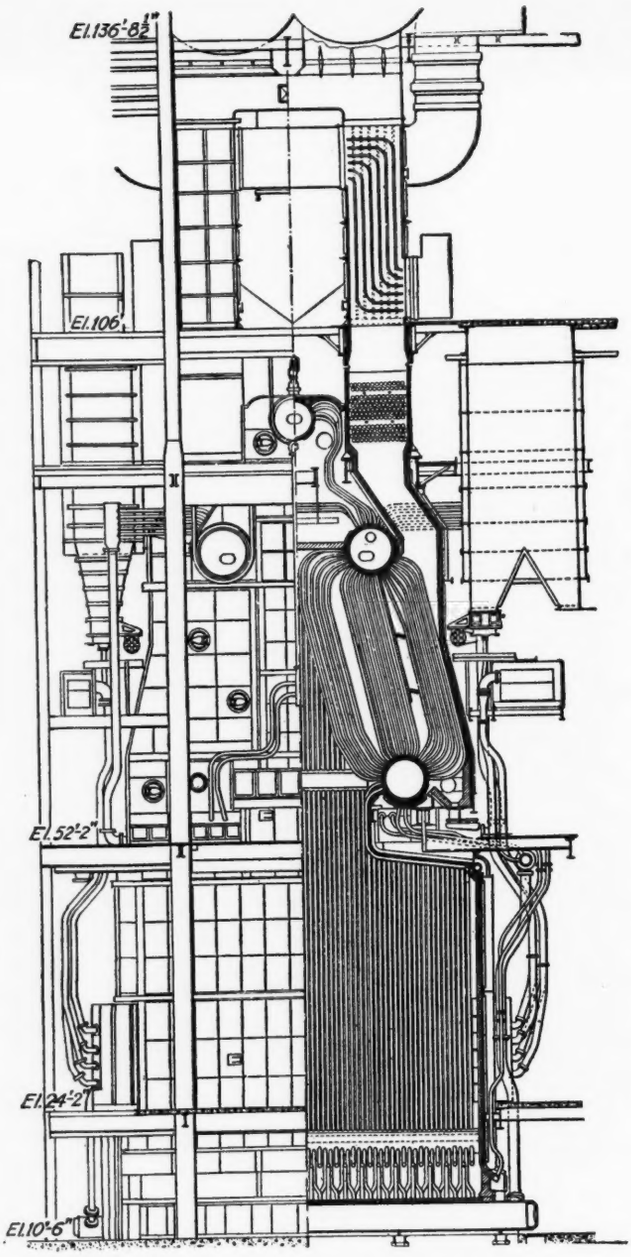
This new boiler is being installed without changing any of the steel columns originally designed to support the original lower capacity boilers. In width the boiler is within the boiler column center, but in depth the furnace walls extend about 6 ft. beyond the column center lines, and the bottom mud drum extends about 11 ft. beyond the center line on each side.

The heating surface in the boiler amounts to 34,260 sq.ft. That in the water wall is 8,120 sq.ft., making a total of 42,380 sq.ft. The water walls and first bank of






The first boilers were designed to evaporate 325,000 lb. of steam per hour




The new boiler has twice the output with the same column centers

boiler tubes surround a furnace of 32,000 cu.ft. It is 25 ft. 6 in. wide, 36 ft. deep from front to rear wall, and 31 ft. high between arch and bottom screen. At maximum guaranteed rating the heat liberated in the furnace will be about 28,700 B.t.u. per cubic foot of furnace volume.

### Furnace Volume Increased

Design of the new unit started with the ashpit. The distance between the slag screen tubes and the ashpit gate was decreased to the minimum indicated by previous experience. The ash gates and ash-sluicing equipment were lowered as far as the ash-sluicing arrangement in the plant would permit. These changes resulted in lowering the bottom mud drum 5 ft. 10 in., and the top of the slag screen 7 ft. 7 in., thus making possible a considerable increase in furnace volume. To make this change, the bottom mud drum was placed perpendicular to the center line of the main boiler drums instead of parallel, as in the previous boilers. This drum is 36 in. inside diameter and 40 ft. 6 in. long. The seams of this unusually long drum were all hammer-welded.

Occasional difficulties with low-fusion-point ash in the older boilers led to the installation of a slag screen consisting of three rows of staggered tubes instead of the usual one row normally installed. This arrangement, it is expected, will lower the temperature of the ash sufficiently to prevent the formation of clinker in the ashpit.

This unit is the last in a battery of three boilers, and the possible depth of the furnace was determined by the clearances necessary between the boiler and the building wall, and between the boiler and the adjacent row of boilers. It was found that the furnace could be made 36 ft. deep, an increase of about 8 ft. over that possible with the other boilers. This dimension practically determined the furnace volume that could be obtained, because the width of the boiler is fixed by the center line distance between the boiler columns, and its height by

the location of the arches and mud drum, which it was desirable to keep at about the same elevation as in the other boilers.

The obtainable furnace volume, together with an assumed maximum heat liberation per cubic foot of furnace volume, gave an estimate of the maximum amount of heat that could be delivered to the boiler, and, therefore, an estimate of its maximum steaming capacity. The next problem, then, was to install steam drums of sufficient size to handle the indicated evaporation, and sufficient boiler, economizer and air preheater surface to lower the temperature of the flue gas to an economical value.

The two lower water drums are 54 in. in diameter and 28 ft. 8 in. long. They are located at an elevation a few feet higher than that of the older boilers, but the same distance apart. The two steam drums are 60 in. in diameter and 33 ft. 2 in. long. These drums also are located the same distance apart, but are at an elevation 3 ft. 10 in. higher than the similar drums of the older boilers. The dry drum is 48 in. in diameter and 33 ft. 4 in. long. It is located about 7 ft. higher above the steam drum than in the previous units.

The increased diameter of the steam and water drums of the new unit made it possible to install tube banks 21 tubes wide between each of the two pairs of steam and water drums, whereas in the older boilers the tube banks were only 9 and 13 tubes wide. This increased the amount of surface in the boiler proper to more than three times that in the 1926 unit. The tubes are 3¼ in. diameter and placed on 7-in. centers, which is somewhat more than usual practice for this type of boiler. The purpose of this was to decrease the draft loss through the unit.

The water walls are of fin-tube construction and arranged much the same as in the older unit, except for certain changes made necessary by the rearrangement of the ashpit screen and bottom mud drum. The front and rear walls are fed with water through downcomers from the boiler water drum, while the side walls are fed from the bottom mud drum, which, in turn, is connected at each end through two 12-in. pipes that connect to headers located in front and at the rear of the boiler just under the operating floor. The headers are fed by connections to the bottom water drum.

In the previous units the dry drum was drained through tubes to the steam drums. In the new unit a header runs under the dry drum and is connected to it by a number of short nipples. This header discharges to the top headers of the bottom side-wall screen.

### Wider Economizers Installed

The economizers, as previously, are installed in the two uptakes from the boiler. They are wider and have the same number of tubes high as the older units. They are of the extended-surface tube type and contain a total of 19,656 sq.ft. It was found possible to increase the tube lengths from 20 to 21 ft. The air heaters are practically the same as installed in the previous unit, except that the width of the flue gas pass has been increased, and also the surface to 61,440 sq.ft.

The increase in the width of the economizer, the air preheater, and the more liberal spacing of the tubes in the boiler have resulted in a decrease in the draft loss through the boiler. It is estimated that at 750,000 lb. of steam per hour the draft to be produced by the induced-draft fan will be 9¾ in., which is considerably less than that required of the fans serving the 1927 unit when operating at the same rating. Two induced-draft fans, each of 250,000 cu.ft. per minute capacity, designed to operate against a 16½-in. static head, have been installed. They are driven by a 1,073-hp. motor at 583 r.p.m. The fans for the 1927 unit were designed for a static head of 22½ in. The forced-draft fans are on the same floor as the induced-draft fans, and each has a capacity of 125,000 cu.ft. per minute at 12½-in. static pressure. These fans are driven at 865 r.p.m. by a 362-hp. motor. The induced-draft fans discharge through Cottrell precipitators to the single stack which also serves the other boilers.

Increased steam generating capacity required the installation of additional pulverizing equipment, and a 40-ton Fuller-Lehigh mill is provided. This mill is of new design. It has a double row of balls one on top of the other but separated by a grinding ring flexibly connected to a vertical shaft. The vertical shaft is driven by a direct-connected 500-hp. vertical synchronous motor.

Pulverized coal is fed from front and rear steel bunkers by eight table-type feeders, each supplying two burners. Four burners are located at each corner of the boiler and directed toward the center tangent to a circle about 9 ft. in diameter. Primary air is furnished from a duct system. Two primary air fans of 22,000-cu.ft. per minute capacity at 16-in. static pressure and 350 deg. F. were added to the capacity of primary air fans already discharging to the common duct.

### Auxiliary Equipment

A 4,000-kw. extraction turbine is to be added to the electric generating capacity, which at present consists of three 3,000-kw. units. These units supply electrical energy for auxiliary drive, and exhaust to the feed-water heating system. The new unit will exhaust at 5 lb. pressure for feed-water heating. Steam will be extracted at 170 lb. and delivered to the steam mains leaving the station, after the reducing valve. Sufficient steam will be delivered to the low-pressure stages of the unit to provide the steam necessary for feed-water heating. Additional auxiliary power required that is not generated by the steam passing to the feed water heating system will be generated by steam extracted at 170 lb. pressure. The unit is capable of delivering up to 400,000 lb. per hour of extracted steam to the outgoing mains.

Other auxiliary equipment to be installed with the new boiler unit are two 1,500-gal. turbine-driven Cameron feed pumps and a feed-water heater of 700,000 lb. per hour capacity.

Steam from the new unit is delivered from the dry drum through four 12-in. nozzles to an 18-in. header, each end of which discharges to a 24-in. steam line. Each of the 12-in. lines from the boiler is provided with S. & K. non-return valves.

The contracts for this unit were let March 13, and it is scheduled for operation by the middle of November. If this schedule is met, the fabrication and installation of the unit will have been accomplished in excellent time. It is expected that during the coming season's operation about 50 per cent of the unit's capacity will be required. If building costs are considered, the increased capacity of this unit has made it possible to secure steam-generating capacity for considerably less money than in the previous installation. This unit is the next to the last to be installed in this section of the plant, and because of its increased capacity the time when a new boiler house would have to be built has been very considerably postponed.

# SIMPLE LOG SHEET FOR A DIESEL PLANT

DAILY OPERATING LOG _____ COMPANY _____ STATION, CAPACITY _____ KW.

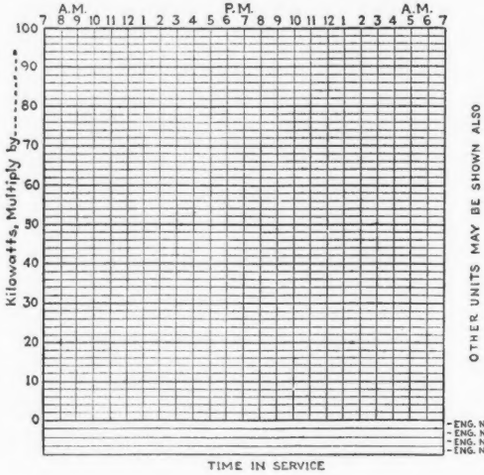
FOR 24 HOURS BEGINNING AT 7 A.M. _____ DATE

| | TIME | TEMPERATURE: OUTSIDE | TEMPERATURE: ENG. ROOM | TEMPERATURE: ENG. WATER IN | ENGINE No.1: K.W. METER | ENGINE No.1: ⊗ TEMPERATURE: EXH. | ENGINE No.1: ⊗ TEMPERATURE: WATER OUT | ENGINE No.1: ⊗ TEMPERATURE: OIL IN | ENGINE No.1: ⊗ TEMPERATURE: OIL OUT | ENGINE No.2: KW. METER | ENGINE No.2: ⊗ TEMPERATURE: EXH. | ENGINE No.2: ⊗ TEMPERATURE: WATER OUT | ENGINE No.2: ⊗ TEMPERATURE: OIL IN | ENGINE No.2: ⊗ TEMPERATURE: OIL OUT | ENGINE No.3: KW. METER | ENGINE No.3: ⊗ TEMPERATURE: EXH. | ENGINE No.3: ⊗ TEMPERATURE: WATER OUT | ENGINE No.3: ⊗ TEMPERATURE: OIL IN | ENGINE No.3: ⊗ TEMPERATURE: OIL OUT | ENGINE No.4: KW. METER | ENGINE No.4: ⊗ TEMPERATURE: EXH. | ENGINE No.4: ⊗ TEMPERATURE: WATER OUT | ENGINE No.4: ⊗ TEMPERATURE: OIL IN | ENGINE No.4: ⊗ TEMPERATURE: OIL OUT |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FIRST SHIFT | 7 | | | | | | | | | | | | | | | | | | | | | | | |
| | 8 | | | | | | | | | | | | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | | | | | | | | | | | | |
| | 10 | | | | | | | | | | | | | | | | | | | | | | | |
| | 11 | | | | | | | | | | | | | | | | | | | | | | | |
| | 12 | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | | | | | | | | | | | | |
| SECOND SHIFT | 3 | | | | | | | | | | | | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | | | | | | | | | | | | |
| | 5 | | | | | | | | | | | | | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | | | | | | | | | | | | |
| | 7 | | | | | | | | | | | | | | | | | | | | | | | |
| | 8 | | | | | | | | | | | | | | | | | | | | | | | |
| | 9 | | | | | | | | | | | | | | | | | | | | | | | |
| | 10 | | | | | | | | | | | | | | | | | | | | | | | |
| THIRD SHIFT | 11 | | | | | | | | | | | | | | | | | | | | | | | |
| | 12 | | | | | | | | | | | | | | | | | | | | | | | |
| | 1 | | | | | | | | | | | | | | | | | | | | | | | |
| | 2 | | | | | | | | | | | | | | | | | | | | | | | |
| | 3 | | | | | | | | | | | | | | | | | | | | | | | |
| | 4 | | | | | | | | | | | | | | | | | | | | | | | |
| | 5 | | | | | | | | | | | | | | | | | | | | | | | |
| | 6 | | | | | | | | | | | | | | | | | | | | | | | |

## DAILY SUMMARY

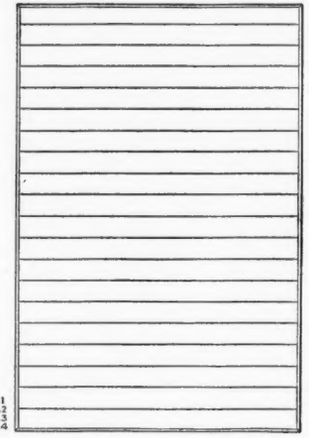
| | DIESEL ENGINE / CAPACITY, HP | No.1 | No.2 | No.3 | No.4 | REMARKS |
|---|---|---|---|---|---|---|
| TIME | Taken off | | | | | FIRST SHIFT |
| | Put on | | | | | |
| | Time in service | | | | | |
| LOAD | Meter ending | | | | | |
| | Meter beginning | | | | | |
| | Difference | | | | | Eng'r sign. |
| | Meter constant | | | | | SECOND SHIFT |
| | Kilowatt hours | | | | | |
| FUEL | Meter ending | | | | | |
| | Meter beginning | | | | | |
| | Difference | | | | | |
| | Meter constant | | | | | Eng'r sign. |
| | Gallons | | | | | THIRD SHIFT |
| LUB. OIL | Meter ending | | | | | |
| | Meter beginning | | | | | |
| | Difference | | | | | |
| | Meter constant | | | | | |
| | Gallons | | | | | Eng'r sign. |
| WATER | Meter ending | | | | | FOURTH SHIFT |
| | Meter beginning | | | | | |
| | Difference | | | | | |
| | Meter constant | | | | | |
| | Gallons | | | | | |
| | | | | | | Chief Eng'r. |

DAILY LOAD CURVE




ADJUSTMENTS, CLEANING REPAIRS AND REPLACEMENT

OTHER UNITS MAY BE SHOWN ALSO



## DAILY PLANT TOTALS

| ITEM | QUANTITY | UNIT COST | TOTAL COST |
|---|---|---|---|
| Labor | | | |
| Fuel oil | | | |
| Lubricating oil | | | |
| Water, City | | | |
| Chemicals | | | |
| Waste and miscellaneous | | | |
| Repairs and renewals | | | |

TOTALIZING KW. METER

Meter ending _____

Meter beginning _____

Difference _____

Meter constant _____

Station total, kw. _____

Power factor ____%. Total _____

Max. demand (Max. 15 minute peak in kw.) _____

Operating load factor (Ave. load ÷ max. load) _____

Operating cost per kw.-hr. _____

Pounds of fuel oil per kw.-hr. _____

Pounds of lubricating oil per kw.-hr. _____

Note:- ⊗ *Average of all cylinders, maximum not to exceed average by more than 20° for exhaust, 10° for water, 10° for oil*

_____
Chief Engineer

# PLANT RECORDS

## *Prove the Engineer's Worth*

By L. A. PEASE
*Assistant Director of Engineering, Fairbanks, Morse & Company*

**The average Diesel engineer should give thought to ways and means of impressing the management with his ability to hold down operating costs—a very necessary thing if his salary check is to show an increase**

INSTALLATION of a prime mover of any type is for a definite purpose, purchased at a definite price because it is considered by those purchasing it, when all facts are weighed, that it will be the most economical power producer for the particular plant.

Considerable search is usually made into the performance of the several types of power supply and their application to the situation at hand. The study of the problem, the choice of equipment, the installation and the operation of small plants are usually left to the operator, who has more or less knowledge of conditions. When the equipment is put into operation, except in a few cases, he does not hear from his superiors except when they are pressing him for a reduction in cost of power or for the use of a cheaper fuel.

It is difficult for the operator of a small plant to secure the approval and installation of adequate metering equipment to enable him to keep accurate records and know exactly what he is doing; in fact, it is seldom done, except when the management has had previous experience in the production of power.

With high-class operation and careful records there is usually little difficulty in showing the management the economy of an existing installation compared with any other form of prime mover. Records permit the engineer to keep the management informed at all times of the cost of the power he produces and offer a definite comparison with results he might obtain from other sources, as well as the cost to other manufacturers in the same line of business.

It is not possible here to show detail records of every type of Diesel plant. However, it is possible to give a few records from which any first-class operator may secure enough data to enable him to make a detailed log for his own plant.

A record to be of maximum use should indicate at least three things, namely: The material, labor, and cost of producing the power; performance of the equipment under the conditions imposed upon it; and the character of the load, including the demand, load factor, and quantity of energy produced.

In looking over many operating logs I find that few of them include sufficient data on all three of these points to permit one to compare closely with plants of other design, or plants employing other prime movers used in the same or equivalent industry.

An electric plant is most adaptable to the proper metering of its output. Therefore, I suggest a log for that type of plant; for other types of drive it will be necessary for the operator to study his problems and apply metering equipment just as far as possible. There are a number of manufacturers of metering equipment who are always glad to show where their product may be applied to the metering of power of various kinds.

The log outline on the opposite page may be used as shown or changed to meet local conditions. At the upper left-hand corner is recorded the time, temperature, and output of each unit. As laid out, this sheet covers only the average exhaust-gas and average cooling-water temperatures. While many operators will prefer to record the individual temperature on each cylinder, that is not necessary if the plant operator keeps the maximum variation within the limits as prescribed by the manufacturer. Putting down individual temperatures on a piece of paper and adding them up and getting an accurate average will, I believe, actually produce better results than plotting each temperature of each cylinder hourly. The item "Oil, in and out," is for oil-cooled pistons and need not be used where oil cooling is not employed. The kilowatt-hour meter is read hourly, and, except when a demand is made for fifteen-minute periods, this will also serve to secure the maximum demand on the plant. If fifteen-minute peaks are wanted, they should be recorded on a graphic demand meter.

The lower left-hand corner contains a graph upon which may be plotted, at the bottom, the continuity of the engine operation. This is done by drawing a horizontal line at the top of the sheet corresponding to the hours of operation of each unit. Thus one may see at a glance, when going through the records, all of the equipment that has been in operation.

In the upper part of the same section may be plotted the kilowatt-hours, or any other unit that the plant might produce, such as gallons of water pumped, barrels of oil pumped, barrels of flour made or cubic yards of material hauled. The scale can be arranged to suit individual conditions.

There is a space for adjustments, cleaning, repairs,

and replacements. This is important, as the condition of the apparatus should be followed closely. Also it offers a record of the cost and the difficulties experienced. The upper right-hand section of the sheet gives the quantities of fuel, lubricating oil, water, unit output, and time in use of each of the units. This, with the factors shown in the lower left-hand corner, completes the cost and performance items mentioned previously in this discussion.

### Finding Daily Costs

The record under the heading "Daily Plant Total" is the costs of labor, fuel, lubricating oil, water chemicals, and repairs, all of which go to make up the operating cost and which when completely filled out each day show the management the accurate daily balance of the power plant operating cost. To be of maximum value, these items should be handled exactly like one would a bank account.

In going over this form it will be noted that it does not contain such items as "volts hourly," "amperes per phase," "field amperes," "exciter volts," and "amperes." In a well-equipped plant with automatic regulation and with first-class supervision it is far more profitable for the operator to keep the equipment in a high state of efficiency rather than to spend his time putting down items that are really of no direct use, unless the conditions are such that the power factor might overload the generator or badly unbalance the circuits. These, however, can easily be checked daily. The voltage of a plant should, where it is important, be recorded. This should be done on a graphic chart and ought not require the time of an operator to watch it

As an aid to the operator, it is well to have printed on the back of the log sheet a maintenance record showing how often the major engine parts should be inspected, so that he may be sure he does not overlook any important item in the maintenance of his engine. The operator can always obtain this from the engine manufacture, who as a rule, has a standard form of maintenance.

This type of log can be altered to conform readily to any kind of Diesel plant. For instance, in a Diesel-electric pumping plant it is merely necessary to add columns for the metering of water pumped. This could be worked up in the form of gallons of water pumped per gallon of fuel, per gallon of lubricating oil, or per kilowatt-hour. And for a Diesel-electric flour mill the total record of kilowatt-hours could be kept as shown on the form, and in addition the total number of barrels of flour produced daily could be recorded.

A monthly sheet could be similar to the daily sheet, except that 30 days would be scbstituted for the 24 hr. and the graph would be made monthly instead of daily.

### A Summary for the Manager

If this form is filled out and summarized each day the owner of a Diesel plant will be definitely assured that he is getting the most out of his plant that it is possible to get, and will have a close comparison with what power costs under similar conditions in other plants.

The engineer, if his records are good, can justly expect a material gain for himself in the form of salary.

▼ ▼ ▼

# Automatic Voltage Control for Small Generator

By G. A. Spohn
*General Electric Company*
*Cincinnati, Ohio*

At the Barrett Line Quarries, Paducah, Ky., there is a small alternating-current generator with a direct-connected exciter which is used to supply power for lighting and for one comparatively large motor. The motor is used to drive a stoker and is automatically started and stopped by means of a pressure switch. During each starting cycle the voltage dropped to such an extent that the motor's torque was insufficient, and it was necessary to increase the field excitation on the generator to get the motor up to speed. After the motor was started the field rheostat had to be adjusted to reduce the voltage to normal. Inasmuch as the motor was started automatically, it caused considerable trouble to adjust the field rheostat manually for each starting, so the arrangement shown in the diagram was adopted to correct the difficulty, using two new relays.

When the pressure falls to a predetermined point the pressure switch causes voltage relay *V* to close, and the coils of multiple relay *M* and timing relay *T* are energized. The normally open contacts of the multiple relay *M* short circuit the field rheostat of the exciter and thus apply full field to the small generator. The normally closed contacts open and disconnect the lamps from the line.

The timing relay closes its contact 1-2 instantaneously, which energizes the magnetic switch and connects the motor to the line. After a definite time interval, the 2-6 finger opens and drops out the multiple relay. This puts normal excitation on the small generator and again energizes the lighting circuit. The setting of the timing relay is such as to allow the motor to get up to speed before the multiple relay is de-energized.

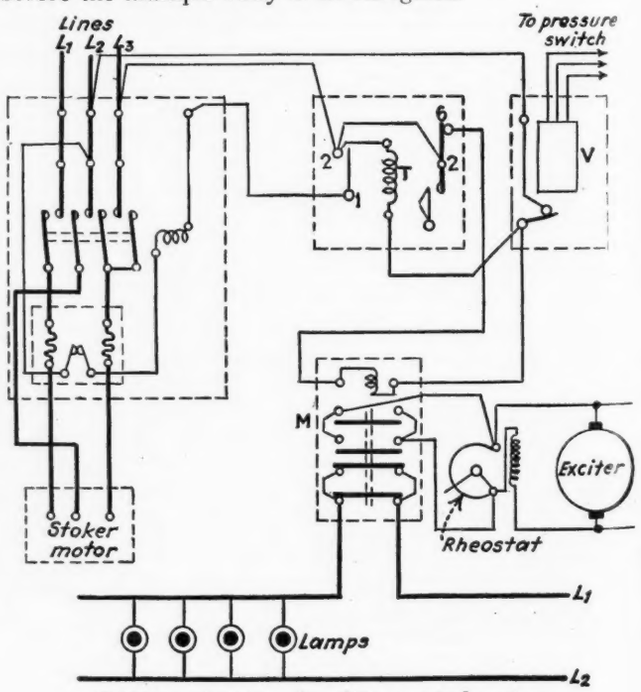
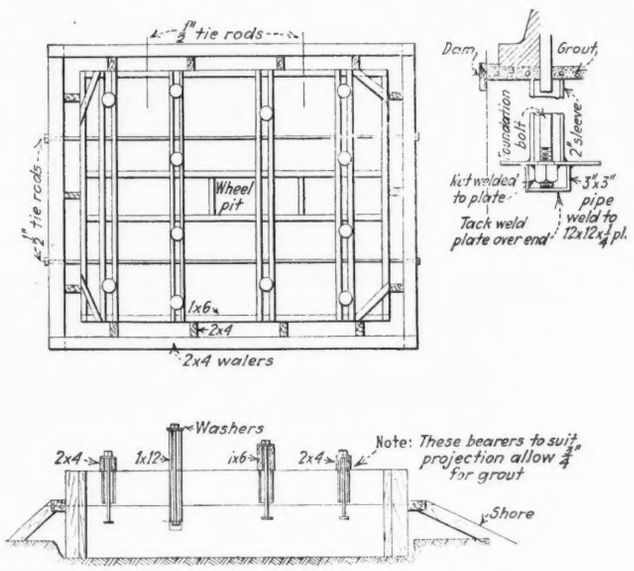



Diagram of automatic-voltage control system

# . . . RIGHT OUT OF THE PLANT . . .

## Foundation for Small Compressor or Engine

WHEN installing a compressor, the manufacturer usually supplies a foundation drawing. These dimensions must be adhered to in so far as bolt centers and outside dimensions are concerned. In sandy or filled ground the base must be designed to suit these conditions. In building the forms the outside of the concrete slab or base is made up of 1x6 pieces. These are held in place by 2x4 posts nailed securely to the




**Details of form work for compressor foundation**

boards. The frame is set in place and trued up. Then more 2x4-in. walers are fastened on all four sides. A few tie bolts—for small jobs—about ½ in. in diameter are run through and bolted up on the edge of the walers. Each corner is then cross braced to hold it square. The walers are also braced from the ground or building or firmly anchored machinery.

The center line of the machine is laid out over the form with a well-stretched wire. From this center line the centers of the bolts are laid off and chalk lines or wires firmly stretched across, the intersections being the bolt center.

Assuming that the bolts have varying projections, two pieces of wood of suitable depth, bearing in mind that from ¾ to 1 in. must be left for grout, are laid edgewise across the form with a space sufficient to pass a bolt between them. On the under side a piece of 1x6 is nailed with a hole in it for the bolt to pass through. The spacings are laid out on this bearer, and where the bolt comes through the piece of 1x6 a galvanized-iron sleeve about 2 in. in diameter is nailed. These sleeves are to take up any inequalities in the machine foundation holes.

The bolts are usually supplied with a new machine, but if not they can be made up, either hooked or screwed, and a washer and nut put on the end. The length may be taken as about 35 diameters. Where there is a long bolt to go in, say with 12 in. or more of projection, the sleeve can be made of pipe about twice the diameter of the bolt. A large square washer or piece of plate is welded on the end. A hole with sufficient clearance to carry the bolt is burned in it, and a nut is lock welded on the outside. To prevent the threads from being filled with concrete a piece of pipe is welded over the nut and the end is closed off. When the nut is being welded on the plate it is well to have it entered on the bolt to stop any shrinkage that may take place from the heat of the torch. This assembly is then in its correct position, as shown by the stretched wires. A block of wood the thickness of the grout is placed between the bearers and the top of the concrete block. The nut on top is tightened, and it will remain firmly in place. When the forms have been set and braced and all bolts placed, the whole should be carefully checked.

When the concrete has set, being given at least 48 hr., the engine may be placed on the block, the cribbing being removed when the engine is over the foundation bolts. The engine sub-base is let down on to straight liners rather than wedges. If wedges are used, however, they should be in pairs, so that top and bottom are parallel. Also, they should have a slow taper. Liners or wedges are placed as near the foundation bolts as possible, to obviate any distortion of the frame of the engine. Foundation bolts should be tightened down when leveling. They must be loosened to change wedge or liners, and tightened again before checking with the level. The leveling is taken from the crankshaft for one direction, and the guides in the other and should be continuously cross checked until they are accurate. The bolts are then pulled tight and rechecked.

When all is in line a dam is built around the block, about 2 in. from the top, and the grout poured in.

The grout should consist of one part of cement to two parts of clean sharp sand well mixed before adding water. It must be poured quickly after being wetted, because it soon takes an initial set. Grout must be worked back well under all the base, getting a full bearing all over the machine. When the grout has firmly set, the dam or form and leveling liners are removed and the holes are filled with grout.

Calcium chloride in the concrete will give a quick-setting job, but under no conditions should the engine be run before 48 hr. For ordinary cement it should stand four days.

M. C. COCKSHOTT.

Long Beach, Calif.

## Reporting Station Heat Rates to the Nearest B.t.u.

IN THE June 10 number of *Power* there was an interesting article entitled "Powerton Station Shows Excellent Performance." One thing about it, however, immediately caught my attention and detracted from the value which I otherwise would have attributed to the article. This was the reporting of the over-all station heat rates to the nearest B.t.u. per kilowatt-hour.

It is recognized engineering practice to report data of any kind only to the number of significant figures that the accuracy of the data justifies. In other words, a heat rate as reported in the article of 12,546 B.t.u. per kilowatt-hour should mean that in the author's estimation the actual value is between 12,545 and 12,547. This would imply that the data is accurate to within 0.008 per cent, which obviously is absurd. Even the heat rates of turbine-generator units obtained with the most elaborate installation of test equipment and the most experienced test personnel should not be reported any closer than to the nearest 10 B.t.u. per kilowatt-hour. For the over-all station performance the accuracy of the data would be represented much more correctly if the heat rates were rounded off to the nearest 100 B.t.u. per kilowatt-hour. The heating value of the coal also should be reported to the nearest 10 instead of the nearest 1 B.t.u.

PHILIP H. HARDIE,
*Test Engineer*, Research Bureau,
Brooklyn, N. Y. Brooklyn Edison Company.

## Servicing the World's Largest Building

SOME months ago a number of *Power* was devoted almost exclusively to the power plant of the Hotel New Yorker, one of the world's largest hotels. This article was interesting and of particular value to engineers engaged in plant design and operation.

In contrast, is the short, sketchy description of Chicago's Merchandise Mart, entitled "Servicing the World's Largest Building," in the July 8 number. The information given is rather scant and incomplete. I am sure all engineers would appreciate a presentation of the facts and data, including the *analysis* on which the plant design was based.

Readers of technical magazines are too often treated to this type of article in which bare statements are made without any supporting evidence. Take, for example, the statement that appears in the last paragraph on page 46 of the article mentioned, "Alternating current in bulk is purchased for lighting and power at a rate which prohibited a substantial investment in generating equipment, from which much of the exhaust would be wasted to atmosphere for at least six months of the year." Personally, I should like to know where the dividing line in electric rates decides in favor of purchased power when a large steam demand is present and plenty of condensing water is available. Utility rates are public property through the utility commission, and in an article of this kind they could well be stated.

Having been a resident of Chicago for many years, and being well acquainted with Chicago's weather, I am not convinced that the foregoing statement gives the reason for deciding in favor of purchased current. A supplementary article, preferably written by the engineers for Graham, Anderson, Probst & White, who are credited with being the architects and engineers, would clear up the doubt existing in the minds of many engineers and also produce some valuable discussion on building power plants in general.

Engineers accustomed to rivers that run into lakes and oceans should be told that the Chicago River channel is a natural water course, where the cool waters of Lake Michigan are diverted to flow *out* of the lake. The stream pictured in front of the building in the article referred to is this same river. It would appear that condensing equipment under these conditions might have solved the six months' steam wastage mentioned.

In a recent issue a statement was made that the Otis Building found a 33⅓ per cent annual return on its investment by installing a low-pressure turbine, condenser, cooling tower, etc., to utilize the summer exhaust steam excess. This plant is in Chicago's Loop, a few blocks from the furniture mart. I do not hesitate to say that I am sure the operators of the Otis Building will be glad to tell how and why they earn this return.

I may be out of order in presuming to question the statements in the Merchandise Mart aricle, but I am willing to be convinced. There are many companies prepared to finance industrial installations when analysis shows that it is cheaper to generate than to buy. These companies are perfectly willing to back up their beliefs by installing a plant without any initial investment and let the income return their money. In conclusion, I should like to add that there are undoubtedly many companies that could well afford to listen to a proposition whereby equipment would be installed without initial investment, or possibly contract to buy all their requirements from an operating company which would lease the plant from the owners. CHARLES A. CRYTSER.

Los Angeles, Calif.

## Origin of A.P.I. Gravity

IN THE July 29 number of *Power*, on p. 186, it was stated that the A.P.I. gravity is a modification of the Baumé scale.

In my notebook I have the following, which may be of interest to you: It seems that the density of oil several years ago was given in degrees Baumé on an arbitrary hydrometer scale. Now this original scale was sent out to a shop so that a duplicate could be made, and the instrument maker made a mistake in the new scale, which was not found out for some time, with the result there are two Baumé scales.

The Baumé scale was first adopted by the United States Petroleum Institute in 1864. If the specific gravity of an oil is represented by $G$, then according to the U.S.P.I., degrees Baumé $= \dfrac{141.5 - (131.5 \times G)}{G}$

The American Petroleum Institute (A.P.I.), the United States Bureau of Mines, and the United States Bureau of Standards have adopted degrees Baumé $= \dfrac{140 - (130 \times G)}{G}$

CHAS. H. HUGHES.

Staten Island, N. Y.

# Generator Ammeters Give Misleading Readings

THE experiences here related show the extent and direction of current flow in the equalizer connections of compound-wound direct-current generators. In one plant three generators were connected to operate in parallel. As shown in the diagram, No. 1 machine was of the two-wire type and Nos. 2 and 3 were three-wire units. All three machines had their series field windings divided so that two equalizers could be used as is general practice with three-wire generators. The two-wire machine had an ammeter connected in the negative line only, while the other two machines had ammeters connected in both the positive and negative leads.

It was noticed that when either No. 2 or No. 3 machine was in service and No. 1 ready to go in, with the disconnect switches closed but with the breakers open, No. 1 ammeter would read about 300 amp. After the circuit breakers on No. 1 machine were closed, the reading on, say, No. 2 machine ammeters would decrease considerably before No. 1 ammeter would indicate more than the original 300 amp. Then after the load was equalized on the two machines the total would be 200 amp. less than the sum of the ammeter reading before the circuit breakers were closed on No. 1 machine. When the load on the two machines had increased to where No. 3 machine was required, putting this unit into service would cause the total of the ammeter readings to be about 200 amp. less than before the third machine was connected to the busbars. With No. 1 machine carrying the total load, if the disconnect switches on No. 2 machine were closed the reading on No. 1 ammeter would decrease about 200 amp. Closing the disconnect switches on No. 3 machine caused an additional decrease of 200 amp. in No. 1's ammeter reading.

An investigation revealed that No. 1 ammeter was connected between the equalizer and the negative busbar, while the ammeters on machines 2 and 3 were between the equalizer connections and the machines' armatures, as they should be. With the latter arrangement all the current leaving the machines must pass through the ammeters, where on No. 1 machine the current flowing in the lead to the negative busbar only goes through the ammeter.

The arrowheads on the diagram show the path of the current. With No. 2 generator in service and the disconnect switches closed on No. 1 machine, but with its circuit breakers open, 300 amp. flows in the path indicated by the single arrowheads, and is indicated by No. 1 ammeter. After No. 1 machine's circuit breakers are closed and load builds up on the generator the current reverses its direction in the equalizer connections to the sum of 200 amp. and is not registered on any of the ammeters. When No. 3 generator is put into operation 200 amp. more from No. 1 machine bypasses the ammeters. The double arrowheads indicate the path of the current that does not flow through any of the ammeters when machines 1 and 2 are in service and connected in parallel.

I believe it is generally assumed that the current flowing in an equalizer is small and is first in one direction and then the other. The flow seems to be constantly in the direction of the machine the series winding of which has the least resistance. The value of the current depends on the difference in resistance of the different series field windings. In many cases a small amount of current generated by one machine is going through the series windings of the other.

Operators sometimes wonder why, after the load has been reduced to zero on one of two or more machines operating in parallel, the line voltage will rise when the breaker is open on the machine being taken out of service. This is because some of the current from the machines in service was going through the series winding of the machine being shut down. When the breaker was opened this current had to go through the series winding of the machine that generated it, and thereby raised the line voltage.

In one instance, two 1,200-amp., two-wire generators were running in parallel, carrying a total load of 1,200 amp. It was desired to take one of them off of the line, but it was impossible to reduce its load below 400 amp. Even after the other machine had the entire load, according to its ammeter, the other ammeter still registered 400 amp. A check-up of the wiring revealed that one ammeter was connected in the negative line as it should be, while the other was connected in the positive line. The latter was indicating current generated by the other machine that was flowing through the equalizer to reach the main line.

RAYMOND F. BENNETT.

Middletown, Ohio.

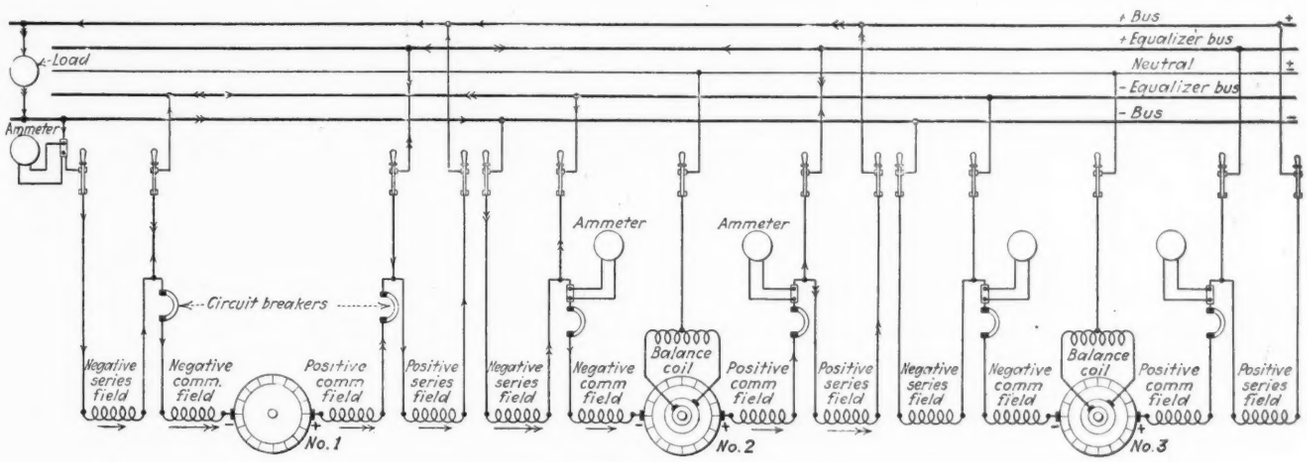



**Diagram of a 2-wire generator connected in parallel with two 3-wire machines**

# From Among Readers' Problems

*Conducted by*
**L. H. MORRISON**

POWER AND STEAM IN PAPER MAKING—*What is the average annual power and steam need in paper mills?*

A.R.S.

The power and steam used per pound of paper depends upon the paper process followed and upon the character of the paper made. The amounts consumed daily in three mills are shown in the tabulation:

| | | | |
|---|---|---|---|
| Total paper, lb. | 53,343 | 30,000 | 80,000 |
| Kilowatt-hours per lb. paper | 1.47 | 1.88 | 2.14 |
| Steam at 20 lb. (dryer) per lb. paper, lb. | 1.97 | 3.36 | 3.52 |
| Steam at 60 lb. (digesters), lb. paper, lb. | 2.42 | 1.24 | 0.62 |

EXTINGUISHING FIRES IN ELECTRICAL EQUIPMENT—*How may fires be extinguished in electrical equipment?*

P.R.

Methods of extinguishing a fire in electrical equipment vary considerably. Water is the best-known medium for quickly putting out an ordinary fire and reducing the temperature of the combustibles, but water as a remedy for fire in electrical machines is almost as bad as the disease, for the equipment must be thoroughly dried out before it is again put in service. Carbon-tetrachloride has been suggested, and although it evaporates quickly and leaves the machine dry it is an excellent solvent and the insulating compounds may be hopelessly damaged by it. Introduction of an inert gas to smother the flame is probably the ideal method. Steam may be regarded as such a medium, but it is potentially liquid water and has all the objections of water. Perhaps the cheapest, most harmless, and still effective, gas that may be used is carbon-dioxide.

CLEANING CONDENSER TUBES—*How much hydrochloric acid must be put in a solution to clean condenser tubes?*

D.W.

Laboratory experiments by one of the builders indicate that the proper acid concentration to use in removing condenser-tube scale is a 2.5 per cent solution by volume of hydrochloric acid for a treatment of one hour's duration. These laboratory tests further indicated that if it was more desirable, either from the viewpoint of economy or from that of time required to clean the condenser, a 1.25 per cent solution of acid could be used for a two-hour treatment, or a 5 per cent solution for a treatment of one-half hour's duration.

With regard to applying this method of acid cleaning of the tubes to actual practice, it is strongly recommended that the tubes be first thoroughly water-tested, to avoid any possibility of acid getting into the condenser hot well and subsequently into the boilers. As a further precautionary measure, where feasible, periods of treatment should be longer, which will permit of a correspondingly smaller acid concentration. So far as the effect of the acid on the tubes themselves is concerned, there is little cause for worry, because laboratory experiments have revealed that a section of clean Muntz tube immersed in a 2.5 per cent solution of hydrochloric acid for one hour experiences a loss in weight of only 0.038 per cent. This same test when applied to standard fiber packing showed that the packing did not decrease in weight in the least and did not deteriorate in any way, so far as could be observed.

The circulating-water system in the 20,000-sq.ft. surface condenser tested held 46,500 lb. of water, or 5,580 gal. For a one-hour treatment 140 gal. of commercial hydrochloric acid should be used. This acid costs 18.3c. per gal. The cost of the acid, therefore, at the existing market price would be $25.20, or if it is desirable to use a two-hour cleaning period, this price would be cut in half, inasmuch as only one-half the quantity of acid would be required. It is therefore evident that the acid method of treatment is not only efficient, but is also cheap to employ.

# PREVIOUS QUESTION

## *Discussed by Readers*

### THE QUESTION

*IS THE daily test of a safety valve by pulling it open, a good practice? Does this not cause leaking?* C.F.B.

TESTS of a safety valve are certainly one of the most important in the power plant. The United States Navy is very rigid in its observance of this duty, and in Article 3073 of its manual of "Instructions and Regulations to the Personnel" says, "The hand gear for lifting the safety valves shall be thoroughly examined at least once a week, whether the boilers are steaming or idle. Whenever steam is raised in any boiler, the safety valves shall be tested by steam and adjusted as necessary to lift at the prescribed pressure. The hand gear shall also be tested at the same time to insure its being in proper working order. These tests of the safety valve and its hand lifting gear shall be repeated once each week while the boiler is under steam. If the safety valves of any boiler cannot be adjusted to lift properly at the prescribed pressure under steam, the fires shall be hauled from the boiler and it shall not be used for steaming until its fault has been corrected."

I have followed the old navy training in respect to tests and inspection, and while I think a daily test is rather strenuous on the personnel and the valves I do certainly believe that once a week should be the rule.

Concord, N. H. C. H. WILLEY.

PULLING a safety valve open to test it is not the best method (and should not be done every day even if employed). It is not an accurate test and is not good for the valve, especially if there is any foreign matter that could get under the valve seat and cause trouble, as few who make these tests hold the valve far enough open to allow the foreign matter to pass out.

There are few places where safety valves are used that a daily test is required. In most cases a test once a week is considered satisfactory. If the valve is to be tested, I believe it is much better to allow the pressure to build up to what the valve is set for, and if it does not operate at this pressure, the pressure should be allowed to build a few pounds higher. After going a reasonable amount above the pressure

at which the valve should operate, but does not, then operating the valve by hand would be all right. But after once operating by hand, the pressure should be allowed to build up to show if the valve will operate of its own accord. If not, it is time to find and correct the trouble.

Hartford, Conn. C. N. JOHNSTON.

It is always good practice to test safety appliances at regular intervals, but there is a question as to whether the safety valve should be opened manually or in the course of regular firing of the boiler.

Several years of firing experience leads me to advise testing, under working conditions, about once a week; unless the valve has been known to have operated in the meantime. To the objection that it is a waste of steam to cause the valve to pop, it can be answered that all insurance, including that of safety, requires the payment of a premium.

I have found that standard makes of safety valves are so sturdily and reliably made that there is little, if any, danger of their leaking under any kind of reasonable treatment. In fact, in Montana, the safety valves used to be set and sealed by the state boiler inspector, and were expected to function perfectly until his next annual visit.

To the first part of the question I would answer "yes," and leave the interval between tests to be decided by each particular operator; but would answer "no" to the second part.

T. C. HULTON, *Master Mechanic,*
Cia Minera Chambas S. A.,
Abras Grandes.
Province de Camagney, Cuba.

TO ANSWER the question dogmatically either in the affirmative or the negative would be wrong. In a plant where conditions are bad, frequent testing is necessary; this is especially true of safety devices placed to protect the equipment against overpressure or overspeeding. Neglect to test safety devices reguarly may result in loss of life or property. In a plant using bad water and experiencing foaming and priming, strict attention must be paid to the safety valve if it is to operate when needed. If a plant is using treated water and foaming and priming are not experienced, the steam flow being steady and popping unusual, testing need not be done daily; about once a week is often enough.

The amount of wear incurred by the valve as a result of testing is almost negligible, for the valve is opened and closed quickly.

A testing schedule should be adopted and rigidly enforced in every plant to protect employees and equipment from injury or possible destruction. Failure to test safety equipment makes it a menace and a liability instead of the safeguard it was intended to be.

Provo, Utah. WILLIAM C. JONES.

DAILY TESTING of safety valves does not require that the lever be tripped each day. If the safety valve pops each day of its own accord due to pressure in the boiler reaching the required value, tripping of the safety valve by the lever is not necessary.

Tripping of the lever daily would not cause the safety valve to leak, but if a safety valve does leak it is undoubtedly due to some other cause, some of which are described below.

The A.S.M.E. boiler code and the state boiler codes require that the safety valves be made to pop daily, but they give no set method or way in which it is necessary to accomplish this result.

Leaky safety valves may be caused by foreign material becoming lodged on the valve seat. If the seat has become damaged by scratching it should be machined or ground in.

Chattering of safety valves will in time cause leakage. This chatter may be caused by wrong adjustment or by the safety valve's not being properly installed.

Where long discharge pipes are used and the weight is not properly supported, leaks may be caused by the unnecessary strain that is thrown on the body of the safety valve, thereby causing distortion of the seat.

The only way in which the lever test can cause leakage of safety valves is where there is a slight drag on the lever. It is not fair to condemn the spring in a safety valve if it will not hold its set pressure or pops too low; the trouble will undoubtedly be found in the condition of the seat.

CHARLES W. CARTER, JR.,
*State Boiler Inspector.*
Binghamton, N. Y.



IF THE safety valve is set to blow off at a pressure far in excess of the normal operating pressure and if the latter is steady, with but a remote chance of the valve ever blowing off during ordinary operating conditions, a daily blow-off by hand may be considered good practice. The scrubbing, sweeping, self-cleaning action produced on the valve seat and valve interior by a hand blow-off tends to prevent any accumulation of foreign matter around the valve seat which would interfere with the free operation of the valve. Leakage from wire-drawing may be minimized by having the valve pulled wide open during the hand blow-off.

In the case of a rapidly fluctuating pressure, a daily hand blow-off should not be necessary, as it is usually convenient to raise the pressure to the blow-off point about twice a week to test the safety valve and keep it in good working order; even this is not always necessary if the fluctuating pressure causes frequent blow-offs.

In the case of little fluctuation in pressure, a hand blow-off or raising the pressure to blow-off point every other day should be sufficient to keep the blow-off valve in good working order.

Brooklyn, N. Y. W. ANDERSON.



NOW-A-DAYS a safety valve is made to meet A.S.M.E. specifications. Its duty on a boiler is to relieve the boiler of excess pressure, and it should be large enough to discharge all the steam the boiler is capable of generating; large boilers are equipped with two or more safety valves to meet this requirement.

A safety valve should pop at a set pressure without manual aid. It is advisable to run up the pressure each day to this point. If the valve fails to operate when this pressure is indicated by the steam gages, the gage should be tested as soon as possible to determine which is at fault.

I consider it bad practice to open a safety valve daily by pulling it. Pulling it open does not injure it or cause it to leak, but has a tendency to defeat the purpose it is intended for if allowed to become a daily habit.

Safety valves should not be tampered with, but kept clean and in good condition so they will be free to act when the occasion demands.

B. E. SMITHERS, *Engr.*
Murry Woods Products Company.
Memphis, Tenn.



THE DAILY test of safety valves set for over 200 lb. will cause leakage only after a long period of use. This can be corrected by grinding in the seat. At pressure below 200 lb. the daily test of safety valves, as a rule, will not cause leakage provided the valve is lifted high enough to blow out any dirt or scale that might lodge between disk and seat.

In several states the law requires daily testing, so that the engineer has no choice in the matter. This rule was formulated because some engineers neglected it to such an extent that the valve became inoperative and failed to relieve when the boiler pressure reached a dangerous point.

Personally, I believe if safety valves are blown once a week, either by pressure or by hand, they will be kept in good working order and will only leak after several years of use.

Stratford, Conn. M. C. NYE.

## A Question for Our Readers

*IF THE engine exhaust can be used for feedwater heating, is a motor or engine drive the best for stokers? At present we are feed heating from a 4-lb. turbine extraction line.* C. DE L.

Suitable answers from readers will be paid for and published in the Oct. 7 number.

# THE ENGINEER'S BO

## Heat Engineering

HEAT POWER. *By Earle B. Norris and Eric Therkelsen. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1930. Cloth, 6x9 in.; 366 pages, 256 illustrations, numerous tables. Price, $3.50.*

SO MANY BOOKS on heat engineering have been published in the last ten years, that it is difficult for a reviewer to display even a budding enthusiasm over a new volume. And one must be forgiven if he takes up the product of a new author with just a tinge of cynicism and boredom. But even in one so blasé, this new treatise by Professors Norris and Therkelsen will strike a responsive chord.

The book is different, and the authors deserve praise for the clarity with which they have discussed the basic principles of heat engines. True the volume is intended, so the preface states, for students embarking upon thermodynamics, but the material is so interesting and basically sound that many who received their sheepskins a decade or two ago will find the book valuable. It does not go completely into any of the several types of heat engines, but even so it should give the student a sound foundation for further study.

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## Locating the Factory

PLANT LOCATION. *By W. Gerald Holmes. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City; 1930. Cloth 6x9 in.; 275 pages, illustrations, charts, and tables. Price, $3.*

WHERE to locate an industrial plant is not so simple a question to answer as it was in earlier days when operations were on a smaller scale, markets were nearer at hand, competition was less keen, and getting goods from the factory to the consumer did not represent so large a part of the cost of production. Fortunately many bright minds have given much study to problems of plant location, and specialists stand ready to come to the aid of the gowing number of those who see the advantage of employing them. Altogether quite a bit has been written on plant location, but it has been scattered here and there. This fact, combined with the growing importance of the subject, makes doubly welcome this comprehensive review of plant location.

After a brief introduction the author takes up the broader aspects of this subject under the heading, Choosing the General Territory. He considers markets, raw material, transportation facilities, freight rates, fuel and power, labor and wages, laws and taxation, and miscellaneous factors. This broad survey made, Choosing the Particular Community is considered. The main topics here are size of the community, labor, electric power, transportation, community attitude, and data gathering. It will be seen that somewhat the same ground is gone over as in Part I, but with a closer approach to location of the proposed plant.

Part III, Choosing the Site, comes still closer. Railway facilities and labor are again considered. Then local transportation, special requirements, and size and cost of plant, the topographical map and available buildings are taken up. An appendix summarizes a plant location survey covering the United States and Canada made by the policyholders' service bureau of the Metropolitan Life Insurance Company in co-operation with the National Electric Light Association, during which 10,267 plants in the United States and Canada were considered.

The book should be useful not only to those who are seeking a site for new industrial plants, but also to plant owners and managers, most of whom need to consider from time to time whether a move to another locality might benefit their enterprise and their customers. Written from an engineering viewpoint, the book should have a strong appeal to many engineers.

*Reviewed by* M. N. BAKER.

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## Storage Battery Practice

STORAGE BATTERIES. *By George Wood Vinal. Published by John Wiley & Sons, Inc., 440 Fourth Ave., New York City; 1930. Cloth, 6x9 in.; 425 pages, 61 tables, 160 illustrations. Price, $5.*

ALTHOUGH the average engineer is likely to look upon the storage battery as an unimportant piece of auxiliary equipment, one does not go very far in considering their application before realizing that batteries are a very important factor in making the advantages of electric power available in many industries. In the power industry, in transportation, and in the transmission of intelligence, batteries serve so many purposes as to justify a book of the scope and breadth of treatment as this one. The present volume is the second edition of a work that first appeared in 1924 and has been completely revised and brought up to date.

This book, which is a general treatise on the physics and chemistry of secondary batteries and their engineering applications, discusses the subject from the chemical, the physical, and the practical viewpoint. The chemical treatment involves the nature and properties of the materials used in battery construction and the reactions that occur during charging and discharging. The physical includes a study of the electrical input and output, the factors that affect the capacity, and the theory of transformation of chemical energy into electrical energy, or vice versa. The practical part of the work deals with the engineering applications of storage batteries. Both the lead-acid and Edison-type batteries are discussed.

A detailed description of the essential process of battery manufacture and the properties of the electrolyte are given in two chapters. Factors that affect battery capacity are described in another chapter. Operation, which includes charging and discharging, the use of rectifiers, battery regulation, cost of operation, and sources of battery trouble, are covered in other chapters. One chapter is devoted to testing of storage batteries, and another describes in detail various applications of batteries and the nature of the service that they perform.

Although essentially a treatment on storage battery engineering, the presentation is practical, and a large part of it can be easily understood by those lacking a technical training. The more technical and mathematical parts of the book are contained in three chapters, which form a comparatively small part of the text and may be omitted by those whose interests are only in the practical uses and operation of storage batteries.

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## Industrial Research

FORSCHUNG UND TECHNIK. *Edited by Prof. W. Petersen in connection with the Allgemeine Electrizitats Gesellschaft. Published by Julius Springer, 23-24 Linkstrasse, Berlin W9, Germany; 1930. Cloth, 8½x11¾ in.; 576 pages, 597 illustrations. Price, RM. 40.*

THIS is a significant publication in which the great industrial organization A.E.G. has released some of its research work for the public. Forty-one articles by foremost specialists deal with atomic physics, electrons, electro-acoustics, electro-optics, electric heating, thermodynamics, steam generation, steam accumulators, capacity and stability of large electrical transmission systems, mercury-arc rectifiers, transformers, gyroscopes, vibration of turbine blades, transformer oils, cables, economic effects of railroad electrification in Germany, etc.

The articles are serious, crisply written, for "those versed in the art," and

# 'S BOOKSHELF

every one of them contains an original research work carried out for the A.E.G.

Let us hope that this book is a forerunner of many more such works sponsored by leading industrial concerns and covering their respective fields of research. The usual monthly publications of such concerns contain now and then valuable reports which deserve collection into volumes such as the *Forschung und Technic*. The layout of the material as well as the printing of the book is excellent.

*Reviewed by* N. ARTSAY.

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## Boiler Scale Study

FORMATION AND PROPERTIES OF BOILER SCALE. *By Everett P. Partridge. Published as Bulletin No. 15 of the Department of Engineering Research, University of Michigan, Ann Arbor, Mich.; 1930. Paper, 6x9 in.; 170 pages, illustrations, charts, and tables. Price, $1.*

INTENDED as a complete review of the information available up to the present year concerning the formation and properties of boiler scale, this study deals with the effects of scale upon boiler efficiency and boiler metal temperature; the chemical and crystallographic determination of scale constituents; the respective solubilities of these constituents in simple solutions, and the possibility of calculating solubility equilibria in complex solutions; the method and rate of formation of scale; and concludes with a brief summary of contemporary methods of scale prevention.

The worth-while point of view taken by the author in preparing this treatise is well expressed in the foreword: "The viewpoint from which it was written was not directly that of scale prevention, but rather of presenting what is known about scale formation in order that the problems involved in its prevention might be attacked in the most rational manner. The material is developed in a technical rather than a popular form, but an attempt has been made to keep the discussion from drifting too far into the realms of attenuated theory. While the writer is of the opinion that one empirically determined fact is worth ten theories, he has nevertheless attempted to include references to all theoretical as well as experimental publications related to the problem of boiler scale."

The treatise is divided into four complete units with a corresponding appendix for each, so that a reader interested in one particular phase of the subject may pursue that without going through the entire study. Much of the material presented is based on various experimental investigations of the author; but Mr. Partridge declares that this has been treated, as far as psychologically possible, on the same critical basis as any information available from the studies of others. Full descriptions of the research apparatus and method of procedure used by the author in these investigations is given in the appendices.

As a whole, the material is treated in a clear, concise manner. Besides presenting valuable original contributions to the subject, the book is the first really comprehensive review of present knowledge concerning boiler scale.

## Diesel Design

DIE BERECHNUNG EINER ZWEITAKT-DIESELMASCHINE. *By Dr. W. Haeder. Published by Richard Carl Schmidt & Company, Berlin, Germany; 1930. Cloth, 5x7¾ in.; 380 pages, 200 illustrations and 37 reduced working drawings. Price, RM 22-50.*

DR. HAEDER'S manuals of machine design are well known, and this last one is a complete log book of designing a 440-b.hp. solid-injection, two-stroke cycle Diesel engine, including scavenging pump, auxiliary compressor, oil and water pumps, etc. Of course, the formulas, values and trends are valid for other types and sizes of Diesels. The sequence and thoroughness of calculations leave nothing to be desired for the routine work, and the lay-out is excellent.

The 37 reproductions of working drawings and the tolerances are valuable material for students. Recent research as well as the current practice are well reflected in the details.

*Reviewed by* N. ARTSAY.

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# Brief Reviews

QUESTIONS AND ANSWERS ON DIESEL, SEMI-DIESEL AND OTHER INTERNAL-COMBUSTION ENGINES, AIR COMPRESSORS, ETC. Third Edition. By John Lamb. Published by J. B. Lippincott Company, Philadelphia, Pa. Cloth, 340 pages; price, $6.—A catechism of Diesel-engine operation written for marine operating engineers and as a preparation for Board of Trade license examinations.

MY LIFE WORK — PRINTING AND SERVICING TRADES. By Robert L. Cooley, Robert H. Rodgers, and Harry S. Belman. Published by the McGraw-Hill Book Company, 370 Seventh Ave., New York City. Cloth, 166 pages, illustrated; price, $1.50.—One of a series of four volumes which give occupational information to help the young man of high school age in choosing his life work. A third of this book is devoted to the opportunities of the stationary engineer's vocation.

ELECTRIC LIGHT AND POWER. Published by Pynchon & Company, 111 Broadway, New York City. Paper, 36 pages; free.—A survey of the world in regard to the extension of electricity and its uses, with 51 countries in brief review.

THE CENTRIFUGAL PUMP. Compiled by F. G. Switzer. Published as Bulletin 401 by Goulds Pumps, Inc., Seneca Falls, N. Y. Paper, 48 pages, illustrated; free.—Covering every phase of the centrifugal pump; from theory to operation, this new handbook presents the most comprehensive and complete data on its subject yet published.

SAXON PUBLIC WORKS, INC. Published by the National City Company, National City Bank Building, New York City. Paper, 33 pages, illustrated; free.—An interesting description of steam and hydro-electric power development in Saxony, Germany.

PROCEEDINGS OF THE MIDWEST BITUMINOUS COAL CONFERENCE, 1930. Published as Bulletin No. 22 by the Engineering Extension Department, Purdue University, Lafayette, Ind. Paper, 219 pages; free.—A complete report of the papers and meetings of the coal conference held at Purdue University, April 9-11, 1930.

AMERICAN STANDARDS YEAR BOOK, 1930. Published by the American Standards Association, 29 West 39th St., New York City. Paper, 104 pages; free.—A condensed review of the standardization activities of the A.S.A. for the year 1929-30, with a complete list of all projects now under way.

TENSION TESTS OF RIVETS. By Wilbur M. Wilson and William A. Oliver. Published as Bulletin No. 210 by the Engineering Experiment Station, University of Illinois, Urbana, Ill. Paper, 38 pages, illustrated; free.—A report of the results of tests to determine the strength of rivets in tension and to determine the initial tension on rivets.

# *American Progress in Coal Firing of Boiler Furnaces*

**Where does America stand today in the coal firing of boiler furnaces? The answer was presented at the recent World Power Conference in Berlin in the form of a symposium of outstanding authorities. This abstract gives the high spots. The connections of the authors are given on another page**

▼

## Introduction

By H. W. Brooks

RAPID as have been the advances made in pulverized coal technology in the United States, the new method has today by no means swept the field. A fair estimate of the total annual tonnage of coal burned under American boilers will approximate as follows:

| | Tons |
|---|---|
| Hand firing | 275,000,000 |
| Underfeed stokers | 100,000,000 |
| Chain-grate stokers | 40,000,000 |
| Pulverized coal | 25,000,000 |
| Total | 440,000,000 |

Even during the past seven years, since pulverized coal has been universally recognized not only as to technical feasibility but also as to operating practicability United States Government statistics have shown that stokers continue to hold their own in serving about 60 per cent of all water-tube boilers manufactured. There is no reason at present apparent why this ratio should not continue. Increasing clarity of perspective is furthering appreciation of American engineers and plant operators that each method has its proper field of usefulness, hence, it behooves us as engineers to establish accurate lines of economic demarcation between the respective fields rather than to regard any one method as the ultimate panacea for all evils of the boiler room.

Both pulverized-coal and stoker-equipment manufacturers have concentrated on that vast field of inefficiency represented by the hand-fired plant. What pulverized fuel has gained at the expense of stokers in the larger and more modern plants, stokers have more than regained in the conversion of hand-fired plants.

## Application of Pulverized Fuel to High-Capacity Units

By E. G. Bailey

BY THE WIDE VARIETY of applications now in service under practically all types of load conditions, pulverized-coal firing has today established itself as being without doubt the most reliable combustion method for high-capacity units. It is sufficiently flexible to permit coal of widely varying grades to be burned in a single installation. Capacity limitations placed upon furnaces because of their inability to withstand the punishment incident to high rates of combustion have been largely removed by water-cooled walls.

Because of added thermal efficiency obtained by the use of higher steam pressures and temperatures it has been found economical to install varying amounts of air heater surface to reduce flue-gas temperatures to the proper point for over-all efficiency. This type of heat-absorbing surface is appreciably less expensive than boiler or economizer heating surface, since it is not subjected to high pressures.

Consideration must, however, be given to the furnace and fuel-burning equipment when preheated air is used. Pulverized coal permits of the successful use of highly preheated air when the furnace is of water-cooled construction. With refractory-lined furnaces using low-fusing-temperature coals, or where the coal is burned on a grate, the preheat temperature must be limited, otherwise furnace and stoker maintenance will be excessive.

Unit pulverizer installations are being widely used because of their comparatively low first cost, simplicity of design, ease of operation, and reliability. In this system the coal is removed from the mill completely aërated and is discharged in the same condition directly into the furnace, with highly preheated secondary air entering through suitable burners, thus permitting of rapid and turbulent mixture of air and fuel, and of positive and simple regulation of combustion through control of air and fuel to each burner.

Continued development and experience have eliminated the original objections to the unit system based upon lack of reliability, continuity of operation, and adaptability to control.

By burning the coal immediately after pulverizing, all of the problems connected with the storage of pulverized coal (such as condensation in the bunker, compacting and channeling of the pulverized coal in the bunker, deterioration of the bunker, bin gates, etc., by the action of the acid formed by condensation and pulverized coal) are eliminated. The dust problem connected with separating the mill air from the coal before discharge to the bunker, and subsequent remixing of combustion air and coal as in a bin-system installation, is also entirely eliminated by the direct-fired system. Expensive coal-dust collecting equipment, frequently a source of operating troubles, is not required. The unit mill equipment can be arranged compactly and in a minimum of space. Automatic combustion-control equipment can readily be applied to this system.

An important factor tending toward the present general adoption of the direct-fired system has been the development of basically sound principles of coal pulverization. Pulverizing mills are available which have no parts requiring lubrication within the grinding zone, and in which the fineness of pulverization is not affected by wear of the grinding parts. Recent developments have been along the line of smoother operation, greater capacity, and lower power consumption for direct-fired installations.

Furnace design and construction have been important factors in the development of high-capacity units. High availability, high efficiency with smokeless combustion over a wide range of capacity, low maintenance, and ease of ash removal are essential. The slag-tap type of furnace is being quite widely applied to pulverized-coal-fired furnaces.

Increasing use of water walls and resulting experience with them has demonstrated the fundamental soundness of their application. With the present-day tendency toward higher-capacity units the possible failure of water wall tubes assumes an ever-increasing importance.

Furnace wall tubes are undoubtedly subjected to more severe conditions than the boiler or superheater tubes. Due to their location they are at times subjected to higher rates of heat input per square foot of exposed tube surface than any other part of the boiler unit. It is important to protect the furnace wall tubes against excessively high rates of heat transfer and to distribute the heat to various portions of the tube without high localized intensity by a coating of slag or other suitable means. This can be accomplished and the strength of the tube effectively supplemented by armoring it with a block structure which will minimize the danger from these sources.

## Industrial Application of Pulverized Fuel

By W. L. Martwick

PULVERIZED FUEL has many attributes to recommend it as a fuel in the industrial plant. Among these are the ease with which it may be burned, the simplicity with which its intensity and rate of combustion may be controlled, the low excess air and the consequent high thermal efficiency, the low losses when the firing equipment is banked, and the wide range of coals which may be handled with high efficiency and without change in the design of apparatus.

The prospective user first assures himself that the cost of grinding the fuel and of burning it is not too great to outweigh the advantages mentioned above. Perhaps the best assurance of its economic value lies in a general confidence expressed by the numerous industrial firms which having once installed pulverized-fuel equipment have not hesitated to extend its application.

In view of the excellent results obtained with the unit system of firing pulverized fuel, American engineering opinion is rapidly trending toward the belief that greater simplicity and lower cost recommend its use in the average industrial plant.

Although heat releases per cubic foot of furnace volume with water-cooled furnace walls have exceeded 40,000 B.t.u., experience has shown that the refractory-lined furnace which necessitates the least maintenance and provides minimum carbon loss is a reasonably large furnace in which the flame travels a considerable distance before reaching the boiler tubes. By "reasonably large" is meant a furnace in which 12,000 to 18,000 B.t.u. per cubic foot per hour is liberated.

The walls of the moderate-duty furnace may be of solid brick if the rate of liberation is not too great, but in general hollow air-cooled walls are to be preferred. They should be installed so that either the bare tube or tubes covered with cast-iron blocks provide effective absorption of the heat.

Ash is generally removed in a solid state from the bottom of the furnace through a sliding gate. In some of the smaller installations it is hoed manually from the horizontal floor of the furnace through a door. Ash removal in liquid form has recently been accomplished with success, and there seems to be every reason to expect that this method will be employed more extensively in future.

There is no burner which under all circumstances can be said to be the best, since the proper type must be selected to suit the furnace and firing system it serves.

## Underfeed Stokers

By F. H. Daniels

IN AMERICA TODAY boilers totaling 90,000,000 sq.ft. of heating surface are equipped with underfeed stokers. A study of statistics compiled by the Department of Commerce clearly indicates the continued popularity of underfeed stokers as a means of burning fuel under steam boilers.

Underfeed stokers are used primarily for burning high-grade bituminous coal having a rather low ash content of high fusing temperature. Their use, when the question of pulverized fuel or stokers is decided in favor of stokers, is almost universal in the Eastern portion of the United States, where the high-grade bituminous coals are used. The question of their use in the Midwestern states, where fuel is of a lower grade, high in ash and moisture, and with ash having a low fusing point, is debatable.

The tendency of the times is undoubtedly toward larger and larger steam-generating units, operated at higher and higher ratings. Consequently, mechanical stokers have been increased rapidly in size, and particularly in the length. In the multiple-retort type stokers are now built to fill up the entire space available under the boiler, and lengths of over twenty feet are not uncommon. This big increase in size has necessitated many changes and refinements in stoker design.

Stoker installations are being operated today at continuous overloads which a few years ago represented the short peak capacities. While there are records of old installations showing operations at 70 to 75 lb. of coal per square foot of stoker area per hour, these cases seemed to be the exception, while today such coal-burning rates are not uncommon. Water cooling of furnace walls has made this higher heat release possible by preventing much of the clinker and slag difficulties and by giving a furnace lining which will stand up under this high heat release.

The use of preheated air has added to the economy of performance. At first it was assumed that preheated air would add only a little to the thermal savings, calculations being based upon the degree to which temperature of the flue gases could be reduced by this method. The use of preheated air resulted, however, in rather remarkable improvement of combustion, so that an unexpected gain was realized. There is still much discussion as to the permissible temperature of preheated air to be used with stoker firing. Most authorities agree that the present economical limit is between 300 and 350 degrees F.

Naturally the demand for increased size of underfeed stokers, the use of preheated air and the higher combustion rates have necessitated many improvements and refinements in stoker design. The increased length of the underfeed retort brought about improved methods of feeding and distributing the fuel. This brought about the development of different mechanisms for controlling the distribution of the coal along the stoker and its travel through the various zones to the ash pit. This problem has been approached by the different stoker manufacturers in different ways. Today stokers are underfeeding coal 18 to 20 ft., compared with 6 to 7 ft. ten years ago. To discharge the large quantities of ash that result from the use of such long stokers, clinker grinders with large and deep clinker pits are used almost entirely on all stokers 15 ft. long or over.

The use of preheated air also demanded changes in the design of stokers. Some means had to be developed for taking care of expansion and contraction of those parts of the stoker subjected to the preheated air. It also necessitated changes in the tuyère construction.

Equally important is the effective control of the air supply. Most of the stoker manufacturers have recognized this, and new methods of controlling the air to the different zones of the stoker have been developed.

## The Traveling-Grate Stoker

H. D. Savage

THE INSTALLATION in America of traveling-grate stokers has been confined to more or less free-burning coals, usually with comparatively high ash content. The widest field is in the Middlewestern states of Illinois, Indiana, Missouri, and Iowa, and in the Eastern states of Ohio, Western Pennsylvania, and Kentucky. Strongly coking coals have not been successfully burned.

In the early nineties Eckley B. Coxe, a prominent anthracite coal operator, developed a forced-draft traveling-grate

## Titles and Connections of Participants in This Symposium

**H. W. BROOKS—*Consulting Engineer*, New York City.**

**E. G. BAILEY—*President*, Fuller Lehigh Company.**

**W. L. MARTWICK—*Vice-President*, Aero Pulverizer Company.**

**F. H. DANIELS—*President*, Riley Stoker Corporation.**

**H. D. SAVAGE—*Formerly President*, Combustion Engineering Corporation.**

**T. H. BANFIELD—*President*, Iron Fireman Manufacturing Company.**

stoker for burning the smaller sizes of anthracite, a fuel not previously successfully burned on any stoker.

Applying the principles of correct combustion engineering, the traveling-grate stoker, with its new feature of forced draft, speedily proved that exceptional results were possible. The use of this type of stoker with forced-draft was quickly extended to non-coking bituminous coals. Furnaces were made larger, and the arches, while retained in the same location at the front end of the stoker, were set considerably higher.

The excellent performance obtained may be credited to the larger furnaces and particularly to the controlled forced-draft zones, which made it possible to vary the air pressure under the grate in accordance with the fuel-bed thickness immediately above any zone. Operation with low excess air resulted, and, in consequence, higher economy.

At the present time, the forced-draft chain-grate is justly considered as unequaled for American free-burning coals of the Middle West, and the lignites and sub-bituminous coal of Colorado, Texas, and the Dakotas; also for anthracite and coke breeze. With a properly designed furnace, and at combustion rates of 30 to 40 lb. per square foot, the loss due to unburned carbon may be kept below 2 per cent and in many cases as low as 1 per cent.

Stokers of this type are in successful use in sizes up to 24x22 ft. (528 sq.ft.). The rapid advance of the forced-draft grate stimulated manufacturers of the older natural-draft grates. In consequence, furnace designs were improved, arches raised, and the relations of arch length, height and position in reference to cold boiler surface studied. The performance of this type has been thereby greatly improved, though it is, and will remain, subject to the inherent limitations imposed by natural draft.

Today it may be said that traveling-grate and chain-grate stokers, either with or without forced draft, will satisfactorily meet a wide range of applications, from the low-capacity, low-cost installations for burning very cheap coal to the modern up-to-date and highly efficient central station in free-burning coal districts. This stoker is self-cleaning, requires little power to drive and low forced-draft pressure. Maintenance costs compare favorably with any other type of stoker. With forced draft, when burning low-grade, high-ash, free-burning bituminous coals or anthracite, coke breeze, lignite and sub-bituminous, the **"chain"- or "traveling-grate" stoker has no equal.**

### Small and Domestic Stokers

T. H. Banfield

**UNTIL** but a few years ago it was generally believed that boilers having less than 2,000 sq.ft. of heating surface could not be equipped economically with mechanical stokers. Possible economies and efficiency increases were considered insufficient to warrant the investment.

Increasing pressure of economic demand has, however, within the past decade forced exhaustive research and experiment in an effort to design a stoker within reach of the average small boiler operator and at the same time to provide economies and benefits even additional to those already possible with large stokers. It was found that any stoker to fit adequately the needs of these smaller boilers must be automatically operated and controlled to provide saving in labor as well as uniformity of steam pressure. The small stoker must be a self-contained unit adaptable to widely differing coals and applicable with minimum alteration to the several hundred different types and makes of small boilers. Thus we eliminate costly overhead entailed in treating each installation as a separate engineering problem and make possible volume production of a standardized unit.

Notwithstanding mechanical obstacles overcome, it can truly be said that the success of small automatic stokers can be attributed more to sound merchandising and standardized production than to any basic mechanical innovation. Manufacturers have been content to provide a standardized unit performing with reasonably high average efficiency under differing conditions rather than to seek optimum technical results in each individual case. Even so, average performance showed savings ranging from 15 to 50 per cent of former costs with hand firing. Such substantial economies more than satisfied the buyers, installation was simplified, and production **of a standardized unit made possible.**

## Safety in the Power Plant Depends on United Effort[1]

By Marin Phillips

*Electrical Superintendent*
*International Paper Company*
*Niagara Falls, N. Y.*

**WHEN** any great calamity **threatens a group** of people or a nation, immediate steps are taken to protect as much of the population from the impending tragedy as possible. Workmen in industry are continually threatened by an invading enemy which takes a toll of human lives and suffering among workers in industry each year.

This enemy is "Old Man Accident," who is always waiting for an opportunity to break through our guards and lines of defense. He is right alongside of us every time we climb a ladder or go down a stairway. Old Man Accident is a foe that never tires and never gives up. He is held in check only by a hard fight on our part.

The battle against accidents is a hard one to fight and a lasting one. If we are to be victorious, we have to organize against it. We have to be continually springing surprise attacks. We have to make plenty of raiding parties and bring back information that will be of assistance to those in charge of plant safety. No battle was ever won without team work. This holds true in the fight against accidents. Every man must contribute something toward making the plant safe. We cannot consider our army well organized until every man becomes a safety inspector.

We may think, well, the plant has a safety director, why should we worry. This is true, but two heads are better than one, and three are better yet when they are all working for the same common goal.

Two men can walk through a plant and one will see an accident hazard that the other will not. Here is where all men in the organization come in as advisers to the safety director. We act in an advisory capacity by giving suggestions on how to improve plant safety. As suggestions on safety are received they can be thrown into a common melting pot and molded into a few good ones that are sure in the **long run to save someone from injury.**

[1]Excerpts from one of a series of talks on plant safety delivered by the author.

## Additional Water-Power Resources Revealed in Canada

**THE GREATEST** water powers in Canada, said to be greater even than those harnessed along the St. Lawrence, have been revealed along the coast of British Columbia, north of Vancouver, by Government engineers during the past summer. Preliminary reports indicate that, in addition to the noted Taseko Chilko Homathko power, with a possible development of 1,200,000 hp., two other sources of electricity have been discovered, bringing the possible development of the coast district up to the impressive figure of 3,000,000 horsepower.

The two new power sites, revealed by recent surveys, are at Tahtsa Lake and Eutsuk Lake. By turning the waters of these lakes westward to the sea, instead of eastward into the Fraser River, engineers believe that 1,800,000 hp. can be harnessed. The third project calls for the diversion of the Chilko waters westward to the sea by way of the Homathko River.

The discovery of this potential new power means that the known available water power sites in Canada are capable of a total development of 45,500,000 hp. In its annual report, published in January, the Dominion Water Power and Reclamation Service estimated that the recorded water power resources of the Dominion at that time would permit of a turbine installation of about 43,700,000 horsepower.

✦

**Recent inquiry into the utilization of hydro-electric forces in Switzerland** has revealed the fact that that country is making use of 74 per cent of all its available resources. This is a higher proportion than for any other country of the world. Germany and Italy have each harnessed about one-half of their available water power resources.

# WHAT'S NEW IN PLANT EQUIPMENT

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING, TRANSMITTING AND APPLYING THE POWER SERVICES

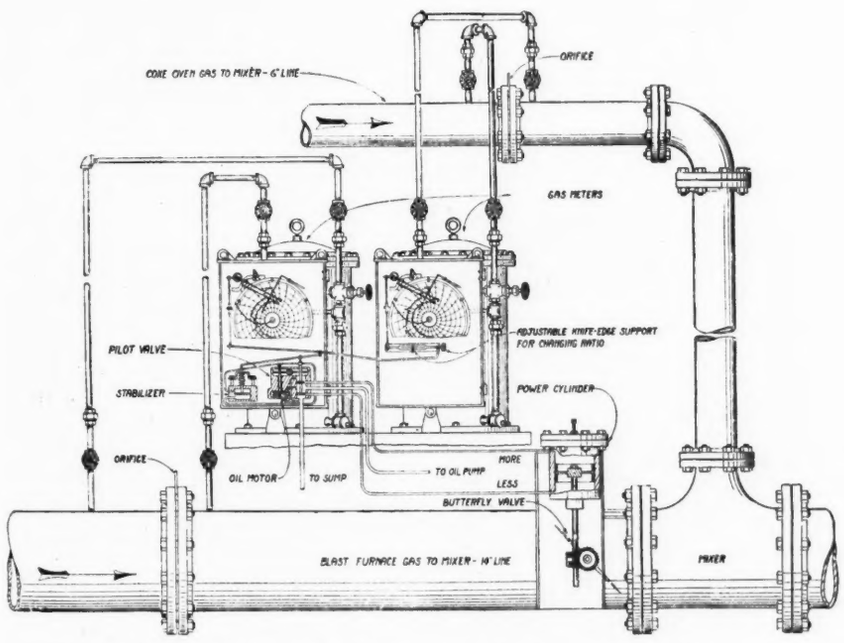
## Automatic Ratio Control for Mixing of Gases and Liquids

A RATIO CONTROL for the mixing of gases or liquids in any desired proportion. and especially designed for application in steel mills, oil refineries, and process industries, has been announced by Bailey Meter Company, Cleveland, Ohio.

The illustration shows an installation of the control to automatically proportion blast-furnace gas and coke-oven gas. As will be apparent, the control is operated by hydraulic pressure. Any change in the rate of flow in the coke-oven gas line is immediately reflected by the gas meter connected to that line. The recording mechanism of this meter is connected though a system of linkage to a pilot valve, stabilizer, and gas meter, which, in turn, is connected to the blast-furnace gas line. If the flow of coke-oven gas increases, the linkage moves and raises the pilot valve, allowing oil pressure to be applied to the "more" side of the power cylinder. At the same time, this movement opens the "less" side of the power cylinder to drain.

The stabilizer tends to counteract the impulse given by the coke-oven gas meter. This is secured by connecting the "more" oil line to the upper chamber of the stabilizer and the "less" oil line to the lower chamber of the stabilizer. As pressure is applied to the "more" oil line, and the "less" side is open to drain, the stabilizer piston moves downward and returns the pilot valve to a neutral position, which, in turn, equalizes the pressures on either side of the stabilizer, causing it also to take a neutral position.

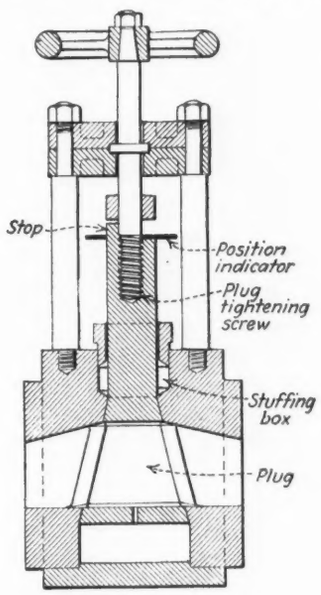
Any desired ratio between the two component parts of a mixture can be secured by selecting the proper ratios for the meter orifices. A further adjustment or change of ratio can be had by use of the ratio-changing device, which is simply a movable pivot supporting the linkage in the right-hand meter casing.




**Typical installation of Bailey ratio control to automatically proportion blast-furnace and coke-oven gas**

## Plug Valve With Non-Sticking and Scoring Features

IN A NEW TYPE of plug valve recently introduced by the Diamond State Machine Works, 12th and Madison Sts., Wilmington, Del., the plug is unseated before it is moved to a new position either to open or to close the passage. This feature assures freedom from sticking and scoring of the plug.




**Cross-section of plug valve**

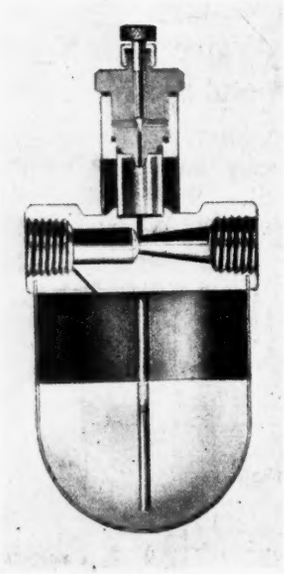
As the handwheel is turned, either to open or to shut the valve, the plug is lowered slightly through the action of the screw, and as the wheel is turned further, the plug turns until the correct position is assumed. Then the wheel is reversed and the plug is again seated. An indicator on the stem shows the position of the plug.

The valve is said to be particularly

suitable for use with acids, solvents, oils, and hot asphaltum. It may be had in all sizes and types and may be made in all commercial materials to meet any requirements.

## Air Line Lubricator

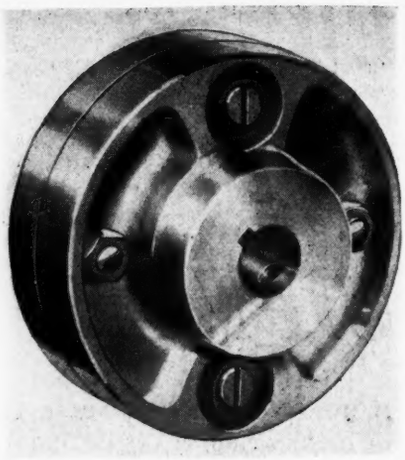
INJECTION of lubricant into the air stream furnishing power to air-operated tools is a function of the Norgren sight-feed automatic air-line lubricator illustrated. It is adjustable to any demand by means of a needle valve. Oil is injected into the air line a drop at a time, which, when it hits the air stream, is dissipated into a fog. The device, which is manufactured by the Carl A. Norgnen Company, Denver, Colo., and distributed by J. N. Fauver Company, 31 Brady St., Detroit, Mich., is available in $\frac{3}{8}$-, $\frac{1}{2}$-, $\frac{3}{4}$-, and 1-in. sizes.



Cutaway view of lubricator

## Flexible Coupling With Aluminum Alloy Flanges

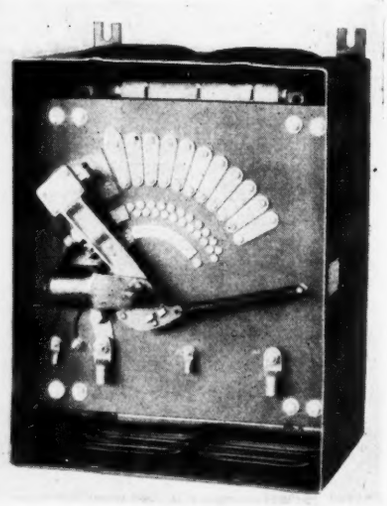
USE OF aluminum alloy flanges characterizes the new type E flexible coupling recently introduced by the Ajax Flexible Coupling Company, Westfield, N. Y. It is of the pin-and-bushing type and is a modification of the type A coupling made for some years by this company. It is fitted with ground alloy steel drive studs and specially compounded rubber bushings cemented to hard bronze bearings. Other details of the coupling are, weight, 2 lb.; outside diameter, 4 in.; over-all length $2\frac{1}{16}$ in.; horsepower, at 1,750 r.p.m. and steady loads, $7\frac{1}{2}$; maximum bore, $1\frac{1}{2}$ inches.



Aluminum-alloy coupling of the pin and bushing type

## New D.C. Speed-Regulating Rheostats

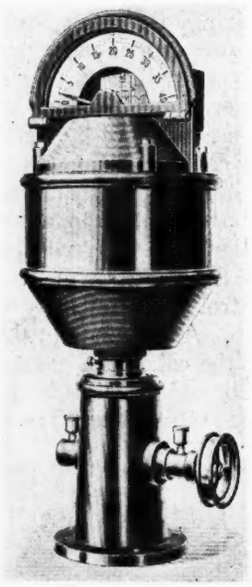
THREE direct-current speed-regulating rheostats, designated Classes 7350, 7310, and 7210, and used for starting and regulating the speed of shunt or compound-wound, direct-current motors in non-reversing service, has been brought out by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. Class 7350 is used where a 50 per cent speed reduction through armature control and 25 per cent increase by field control are desirable, Class 7310 where a 50 per cent speed reduction through armature control only is desirable, and Class 7210 where an increase up to four times full speed through field control is required. In Class 7210, when the arm reaches the position where all of the starting resistors are cut out, the armature contact is held in place by a magnet, which leaves the field contact arm free to move, regulating the speed of the motor. The field contact arm is so interlocked with the armature contact arm that the field resistance can be cut in for speed regulation only when the armature contact is in the "run" position. It must always be returned with the armature arm to the "off" position. This prevents the motor's starting without full field strength on the motor.



Class 7210 speed-regulating rheostat

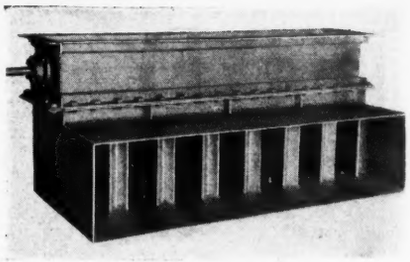
## Mercury-Type Tachometer

THE PRINCIPLE of operation of the new indicating and recording tachometer brought out by the Amthor Testing Instrument Company, Inc., 309 Johnson St., Brooklyn, N. Y., is that of a mercury-filled pendulum which has the form of a U-tube with a flow tube in the center. As the speed increases, mercury is forced into the leg of the U-tube, the level in the center tube falling in direct proportion to the speed. A float transmits this motion directly to the recorder and dial.



Indicating and recording tachometer

This tachometer is suitable for wide ranges in speed from zero to 4,000 r.p.m. with nearly uniform graduation of the scale. Where such a wide range is not required, the lower part of the graduation can be suppressed, permitting of the use of wider subdivisions for the upper working range. The instrument is 40 in. high and utilizes a chart 19 in. long with a recording range $4\frac{1}{2}$ in. high.



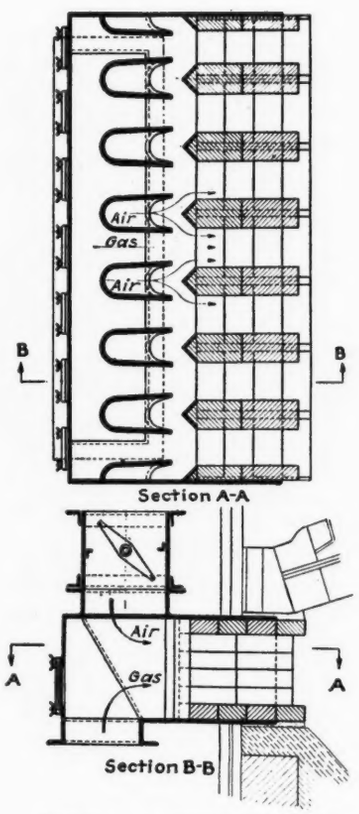
View of burner from furnace side

## Pressure Gas Burner

DESIGNED especially to permit of burning more gas per unit of time than is possible where the supply of combustion air is dependent upon the draft of the stack or aspirating effect of the gas stream, the pressure gas burner illustrated can be had in any desired capacity or width to suit practically any installation requirement. The burner consists of multiple gas and air ports designed to give intimate mixing. The ports are refractory lined, and no metal surface is presented to furnace temperatures.

Referring to the sectional view, gas enters the burner through a bottom connection, and the combustion air from a central fan system enters through a dampered connection at the top, the flow of each being directed as indicated by the arrows. Premixing of the two is accomplished by a series of deflectors at the discharge end of the gas nozzle.

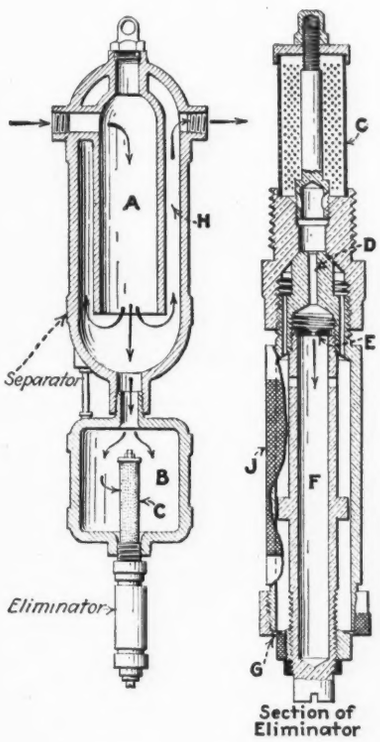
The burner, put out by the Freyn Engineering Company, 310 South Michigan Ave., Chicago, Ill., is suitable for any gas or air temperature or pressure and can also be operated by any system of automatic combustion control.




Sections of burner showing constructional features

## Moisture Separator and Eliminator for Compressed Air Lines

ELIMINATION of water from compressed air as it collects, instead of intermittently, is a feature of the oil and water eliminator now being put out by the Swendeman Corporation, 791 Tremont St., Boston. In the illustration the eliminator is shown attached to the standard compressed air line separator made by the same company. The principle of operation of the eliminator differs from that of a trap in that it is never closed and retains no oil or water, these being expelled immediately.




Sections of separator and eliminator

Air enters the separator as indicated by the arrows and passes into chamber *A*, which has an area nine times that of the inlet. This reduces the velocity and allows the air to expand and precipitate any oil and water into chamber *B* of the eliminator. From this chamber the water passes through screen *C* and the central port of by-pass valve *D* and vent valve *E* to a muffler chamber *F*, being finally discharged to the atmosphere at the point *G*.

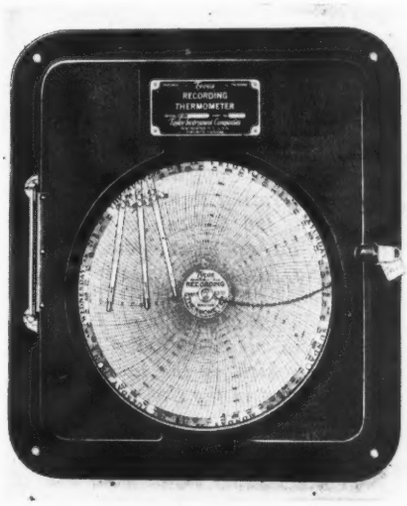
Air rises to the outlet through the expansion chamber *H*, which has twice the area of chamber *A*, this further lessening the velocity and giving more time for precipation of moisture.

To check the operation of the vent the bypass valve *D* is readily opened by turning the knurled body *J* indicated in the sectional view.

## Flush-Mounted Recording Thermometer and Pressure Gage

TO THE LINE of temperature-indicating and recording instruments put out by the Taylor Instrument Companies, Rochester, N. Y., has recently been added the flush-mounted recording thermometer and pressure gage illustrated.

The instrument is designed for panel board mounting and can be supplied with one, two, or three pens. It is back-connected, but is so designed that the operating mechanism or tube system can be readily removed from the front. A micrometer adjustment permits of accurate setting of the pen, which is carried by a suspended stainless steel arm. The case is an aluminum casting finished dull instrument black.




Tycos recording thermometer and pressure gage

# NEWS of the FIELD

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## *Spot News*

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INSTALLATION *of the first X-ray plant of its kind has just been completed at the Barberton (Ohio) works of the Babcock & Wilcox Company. The apparatus, which was supplied by the St. John X-Ray Service Corporation, will be used primarily for routine inspection of welded seams in pressure vessels, heat exchangers, and similar equipment.*

•

A COAL-PROCESSING PLANT *for the conversion of Illinois and Indiana bituminous coals into a high-grade smokeless fuel by low-temperature carbonization has just been opened in Chicago by Thomas Hitchcock, Jr., and C. E. Poyer. The plant has a capacity of 600 tons a day.*

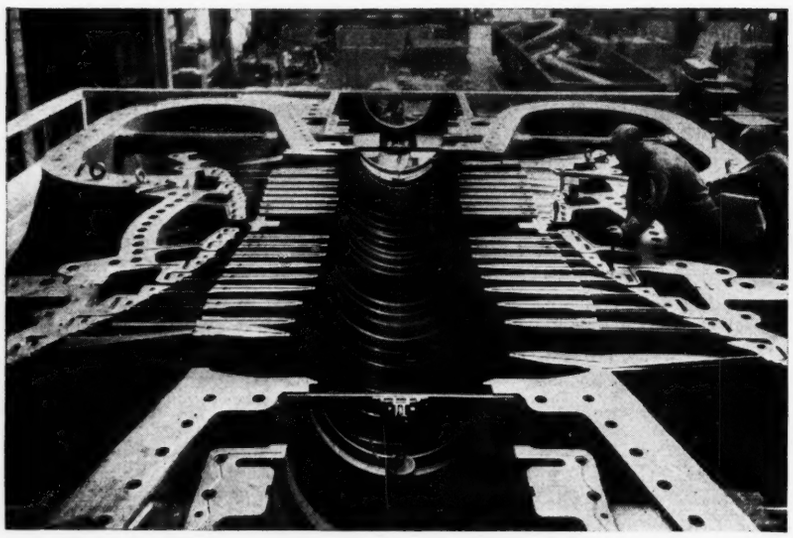
•

WITH FINAL TESTS *of the Georgia Power Company's new 100,000-hp. generating station to be made this month, the dedication of Plant Atkinson, largest steam power plant in Georgia, has been tentatively set for the middle of October. The initial installation at this plant includes a 60,000-kw. single-cylinder turbine-generator which is the largest unit now operating in the South.*

•

TESTS *have recently been carried out in France with a unique pumping plant designed to lift 16,000 gal. of water per hour to a height of 3,000 ft. in two steps, according to reports received by the Department of Commerce. The first step, 1,280 ft. above the well, is now in satisfactory operation. When completed the plant will supply water to the villages of Monnetier-Mornex and Etrembieres through two 40-hp. high-pressure pumps operating in parallel.*

## Largest Vertical-Compound Turbine For Ford Factory Nears Completion



THE LARGEST vertical-compound turbine-generator is now being set up for factory tests at the Schenectady works of the General Electric Company. Workmen are here shown lining up the diaphragms in the lower half of the double-flow, low-pressure unit, part of the 110,000-kw., 1,200-lb. steam pressure turbine-generator for the River Rouge plant of the Ford Motor Company factory at Dearborn, Michigan.

In addition to being the largest vertical-compound machine and the largest turbine-generator to operate on 1,200 lb. steam pressure, it is also the most compact unit yet built. Details of this unit and the new additions to the River Rouge plant were given in the Oct. 15 and 22, 1929, issues of *Power* on pages 621 and 662.

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## British Low-Temperature Coal Distillers Organize

A new association, the Low-Temperature Coal Distillers' Association of Great Britain, has just been formed in London, England, and has as members all the leading firms engaged in the distillation or carbonization of coal at low temperatures. The chairman is Colonel W. A. Bristow; vice-chairman, Lieutenant-Colonel J. T. C. Moore-Brabazon, famous air pioneer; and secretary, Lieutenant Commander Colin Buist. The new body will act as a representative association in all negotiations with the government, the mining industry, the Fuel Research Board of the Department of Scientific and Industrial Research, and other official departments concerned.

The association desires to draw attention to the fact that low-temperature smokeless fuel has for some time past been produced on a commercial scale, and can today be bought throughout the United Kingdom at or about the same price as the best raw coal. Hundreds of thousands of tons of small coal have already been converted into first-class fuel and valuable byproducts. Simultaneously with the production of smokeless fuel, several million gallons of coal oil have been made and sold in Britain, and today the distillation and marketing of coal oils and of gasoline is a factor of growing magnitude in the domestic oil trade.

The association considers that the low-temperature carbonization of coal is now an accomplished technical and commercial proposition, and that such co-operation as it will endeavor to promote will place the new industry on a sound, permanent, and profitable basis.

## Government Extends Stream-Gaging Activities

Extending federal stream-gaging service into new territory, the Water Resources Branch of the United States Geological Survey has opened three additional offices, in Florida, Michigan, and Indiana. This will make a total of 32 offices throughout the country including one in Hawaii. Another district is proposed in a section of the Southeastern states. Last year a sum of $1,200,000 was spent in stream gaging under the Survey including co-operative funds advanced by the states, by local parties, and by the Corps of Engineers. Larger appropriations will be available this year.

The new office serving Indiana and part of Kentucky will be at Indianapolis under the direction of H. E. Grosbach, formerly district engineer in Chicago. The Indiana Department of Conservation is the co-operating party. J. H. Morgan will take the Chicago office. Berkely Johnson will head the new office in Lansing, Mich., in co-operation with the State Conservation and Highway departments. In Florida the State Highway Commission is co-operating in the maintenance of an office at Ocala under D. S. Wallace.

## Pasadena Draws Plans for New Steam Plant

The municipal light and power department of Pasadena, Calif., is advertising for two 15,000-sq.ft. boilers of 450-lb. pressure, together with superheater and water walls, and one 100-ton crane for the power plant for which it is now drawing plans and which it expects to erect this fall. As the size of the turbine will depend on the maximum demand on the department this fall and winter, it has not yet been decided whether a turbine-generator of 15,000-kw. or 25,000-kw. capacity will be installed. If it is finally decided that the department will need a 25,000-kw. unit, plans and specifications for this unit will be drawn some time in the early part of 1931, according to B. F. DeLanty, general manager.

## Engineers Memorial at Louvain Completed

From the tower of the new library of the University of Louvain, in Belgium, the carillon of 48 bells presented by the engineers of this country in honor of the American engineers who died in service during the World War "is singing, and for centuries will sing, the songs of victory," Dr. E. Van Cauwenbergh, librarian of the university, declares in his annual report on the Louvain Memorial to the American Engineers' Memorial Committee, of which Dr. Alfred D. Flinn, director of the Engineering Foundation, is chairman.

Under the direction of a committee headed by Dr. Edward Dean Adams, engineer and financier of New York, 56,000 engineers raised a fund of $80,000 to establish the memorial, which consists of a clock and carillon, formally turned over to the University at an international ceremony on July 4, 1928.

Artisans of France, England and America fashioned the huge clock and the carillon. The works of the clock, which rise 140 ft. above street level, were made in Croydon, England, where tower clocks have been fabricated for centuries.

## Brooklyn Poly to Give Diesel Engine Course

For the seventh year, the Brooklyn Polytechnic Institute of Brooklyn, N. Y., offers to the general public an evening course in the study of the Diesel engine. The course will start Tuesday evening, Sept. 30, at 7:30 p.m. Due to the rapid developments in the use of this engine, the course has been revised to keep it completely up to date with modern practice.

The course will consist of twenty lectures given by Julius Kuttner, editor of *Diesel Power*. In addition a supplementary course consisting of classroom discussions and laboratory experiments is offered. These periods are on alternate Monday evenings, from 6 to 9:30 p.m. Professor F. D. Carvin of the Polytechnic Institute will conduct the classroom discussions. These periods are devoted to an informal discussion of the previous lecture in which the student may ask questions and clear up doubtful points. Professor W. J. Moore of the Institute will conduct the laboratory periods. During these periods, test and demonstrations will be made on Diesel and oil engines in the laboratory.

The course is open to the general public, irrespective of their previous education. Complete information on the course may be had by addressing Professor F. D. Carvin, Polytechnic Institute, 99 Livingston St., Brooklyn, N. Y.

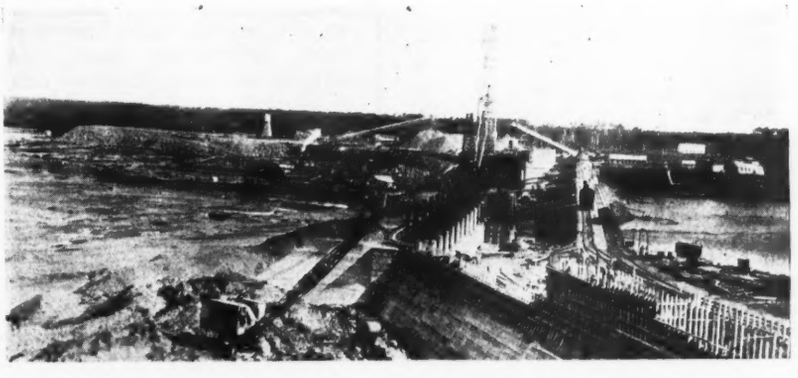
# News of Canada

**West Kootenay gets all Pend Oreille rights—Ruskin network progressing — Upper Notch soon completed**

LICENSES giving entire rights for development of the Pend Oreille River to the West Kootenay Power & Light Company, Rossland, B. C., have been issued by Major J. C. Macdonald, British Colubia provincial water comptroller. The licenses cover a development consisting of two dams, one at Seven Mile Creek and the other at Cedar Creek. These structures together would harness the flow of the river from the Columbia River to the United States boundary and would develop 175,000 continuous horsepower. The company may, however, decide upon construction of one large dam. Now that the water rights have been definitely allotted, no difficulty is anticipated if plans are changed.

ADDITIONS to the power network serving the lower mainland of British Columbia are making their appearance now that the first unit of the British Columbia Electric Railway Company's new hydro-electric plant at Ruskin is nearing completion. Two high tension lines will take the Ruskin power to Burnaby substation, and the work on these is progressing rapidly. The upper river crossings over the Fraser River have their steel towers completed, and there remains only the stringing of the conductors. Erection of steel towers at the lower crossing near New Westminster has gone ahead according to schedule and will soon be finished.

Coincident with this line work, officials of the company report the construction of a 60-kv. transmission tie line between Ruskin and the existing plant at Stave Falls, a distance of about 3½ miles. This means that the three lines running from Stave Falls to the Horne-Payne substation are linked with the new transmission lines from Ruskin to Burnaby, thus wiping out the possi-



**EXCELLENT PROGRESS is reported by the Winnipeg Electric Company on the construction of its 225,000-hp. plant at Seven Sisters Falls on the Winnipeg River, Manitoba. The present state of development is shown in this general view of the project**

bility of any interruption to service should the lines on either side of the Fraser be down or one of the hydro plants crippled.

THE Canada Northern Power Corporation's new hydro-electric development at the Upper Notch on the Montreal River near Cobalt will come into operation some time in October. This development of 13,000 hp. is necessary to permit the company to meet increasing requirements, particularly for the large mining companies in the Kirkland Lake and Rouyn districts. Increase in output on the company's system has been at the rate of about 600,000 kw.-hr. monthly so far this year, and with the extensive additions at the various mines nearing completion a marked increase in output is looked for.

## New York Steam Corp. Reports Increases

The New York Steam Corporation, which is controlled by the Consolidated Gas Company of New York City, reports for the year ended June 30 an increase in sales of steam from 7,731,487,000 lb. to 9,792,410,000 lb., a gain of 26 per cent. Gross earnings were $9,539,538 against $7,786,752, and net profit $1,695,392 against $1,021,484.

Although steam distributed in the fiscal year increased 26 per cent, coal consumption increased only 19 per cent. The efficiency of all boilers averaged 80 per cent. Operating ratio was 56.2 per cent in the 1930 fiscal year, against 78.8 per cent in 1922, but cost of 1,000 lb. of steam to consumers decreased from $1.13 in 1922 to 96 cents in 1930.

The corporation buys steam from the New York Edison Company in the morning hours of January, February and March, when demand for heat is at the peak and when demand for electricity is low, and new machinery for diverting this steam to the steam corporation's system will accommodate 2,000,000 lb. hourly.

## Gilbert Elected President of Barstow & Company

E. M. Gilbert, who has been vice-president and chief engineer of W. S. Barstow & Company, engineers and constructors, was elected president of that organization at a recent meeting of the board of directors. Mr. Gilbert has been actively identified with many important construction projects undertaken by the utility companies with which he has been associated.

Mr. Gilbert was born in Wilton, Conn., and after receiving his technical training in Cornell University he entered the employ of the American Stoker Company, Dayton, Ohio. In 1899 he was sent to London to install stokers in England and France, remaining abroad until 1907 as general superintendent of a parent organization that sponsored the sale and manufacture of stokers in Europe.

After his return to the United States he became chief engineer for the Leadville (Colo.) Light & Power Company, and from 1909 to 1914 he was active in the operation and construction of steam and hydro-electric generating plants for the Colorado Power Company. He was also connected with the construction of the Boulder (Colo.) and Shoshone dams and power houses. He

**E. M. Gilbert**

sponsored the development of oxy-acetylene welding for a steel pipe line over 8,000 ft. long used in connection with Boulder Dam. In 1916 he became general manager of the Metropolitan Edison Company and chief engineer of the properties of the General Gas & Electric Corporation.

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## *How's Business?*

AFTER about two weeks' delay due to drought scare, the signals of the beginning of definite business recovery, which in June we said would appear early in August, begin to flicker faintly amid the encircling gloom. Our index, turning slowly from the low level reached during the first two weeks of the month, has risen to 89% of normal as compared with 87.2% last week and 111.1% last year. Nearly every important weekly indicator has turned upward this week, while a year ago almost all were sliding steadily down. Steel activity, coal production and carloadings are up more than seasonally; electric power output is increasing slowly; building is resisting seasonal decline; general trade volume is rising nearer to normal levels; and commodity prices have ceased their rapid decline.—*The Business Week*, Sept. 3.

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# Personals

R. S. LANE, formerly assistant mechanical engineer with the Interborough Rapid Transit Company of New York City, has just taken a position as mechanical engineer with the Pocahontas Fuel Company of that city.

C. J. ULLRICH, member of the firm of McGonagle & Ullrich, consulting engineers, has been nominated director at large of the American Association of Engineers. Other engineers identified with the power field who have been nominated zone directors of the association include THERNE V. SMITH, member of the firm of Smith & Barnett, engineers, and ERLE K. RAMSEY, consulting engineer.

F. A. ALLNER, general superintendent of the Pennsylvania Water & Power Company, has been named chairman of the American Institute of Electrical Engineers Technical Committee on Power Generation. P. H. CHASE, chief engineer of the Philadelphia Electric Company, heads the institute's Committee on Power Transmission and Distribution. C. W. DRAKE, general engineer of the Westinghouse Electric & Manufacturing Company, has been appointed chairman of the Committee on General Power Applications; P. L. ALGER, assistant of the vice-president in charge of design engineering of the General Electric Company, is chairman of the Committee on Electrical Machinery; and P. P. ALEXANDER, research engineer of the General Electric Company, heads the Committee on Electric Welding. Other appointments as chairmen of general committees of the A.I.E.E. include: W. S. LEE, president of the W. S. Lee Engineering Corporation; J. ALLEN JOHNSON, chief electrical engineer of the Buffalo, Niagara & Eastern Power Corporation; and F. D. NEWBURY, manager of the power engineering department of the Westinghouse company.

BERT H. PECK, prominent engineer, has been selected by the Public Utilities Commission of the District of Columbia to fill the recently created position of chief engineer of the commission. Mr. Peck has had a wide experience with utility and industrial plants, and in his new connection he will organize and supervise the work of the engineering department.

WILLIAM S. MONROE, president of Sargent & Lundy of Chicago, has just returned from a two months' visit to Europe. He attended the World Power Conference at Berlin and toured England and the continent.

R. H. THOMSON, who served as Seattle city engineer under a number of administrations prior to 1912, again has been named city engineer to succeed WILLIAM D. BARKHUFF, who was killed in an automobile accident the latter part of July.

# Business Notes

TROY ENGINE & MACHINE COMPANY, St. Joseph, Mich., announces that the Endberg Division of the company has been moved to Troy, Pa. All communications for this division should be addressed to Troy Engine & Machine Company, Troy, Pa.

WORTHINGTON PUMP & MACHINERY CORPORATION, Harrison, N. J., reports an improved financial status for the first half of this year. As of June 30 current assets were $17,525,690 against current liabilities of $1,225,722, compared with assets of $16,532,255 and liabilities of $813,707 for the corresponding period of 1929. Net income of $1,052,732 for the first half of 1930 was substantially larger than the total net reported for each of the full years 1922 to 1928, inclusive. It was only $46,696 less than that for the first six months of 1929.

JEWELL ELECTRICAL INSTRUMENT COMPANY, Chicago, Ill., announces the appointment of the B. F. Keith Company, Atlanta, Ga., to represent it in Florida, Georgia, South Carolina, and northern Alabama.

CLIMAX ENGINEERING COMPANY, Clinton, Iowa, announces the appointment of the following new dealers: Steeples Engineering Company, 164 Hanford St., Seattle, Wash.; Construction Equipment Company, 1118-24 Hyde Ave., Spokane, Wash.; British Columbia Equipment Company, 551 Howe St., Vancouver, B. C.; Brown-Frazier Equipment Company, 115 Homer St., Vancouver, B. C.; Hall Perry Machine Company, 812 Iron St., Butte, Mont.; Commercial Iron Works, Union Ave. and Stevens St., Portland, Ore., succeeding the J. S. Latture Equipment Company. The Climax Engine Service Company, 115 Broad St., New York City, has just been appointed service repair parts business representative to succeed the John H. Reiner Company.

INDUSTRIAL ENGINEERING AND EQUIPMENT CORPORATION, with offices in the Subway Terminal Building, Los Angeles, Calif., has been established by Emmett H. Jones. This company is engaged in the electrical specialty device business, handling distribution in the southern California territory for the W. N. MATTHEWS CORPORATION and others. Mr. Jones recently disposed of his interests in Jones-Lyman & Company, Inc., and the Utilities Equipment Corporation, San Francisco and Los Angeles.

THE RIC-WIL COMPANY, Cleveland, Ohio, announces that C. W. Lemmerman and Carl Harrington have severed business relations with the company. The New York office, located at 101 Park Avenue, is now under the direction of H. A. Wicks, according to the company's announcement.

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# COMING CONVENTIONS

**American Society of Mechanical Engineers.** Fall meeting at French Lick Springs, Ind., Oct. 13-17. Annual meeting in New York City, Dec. 1-5. Secretary, Calvin Rice, 33 West 39th St., New York City.

**American Institute of Electrical Engineers.** Annual Pacific Coast convention at Portland, Ore., Sept. 2-5. District meeting at Philadelphia, Pa., Oct. 13-15. District meeting at Louisville, Ky., Nov. 19-22. Secretary, F. L. Hutchinson, 33 West 39th St., New York City.

**American Welding Society.** Fall meeting at the Congress Hotel, Chicago, Ill., Sept. 22-26. Secretary, M. M. Kelly, 33 West 39th St., New York City.

**Midwest Power Engineering Conference and Exhibition.** Fifth meeting in Chicago, Ill., Feb. 10-13, 1931. Secretary, George E. Pfisterer, 308 West Washington St., Chicago, Ill.

**National Association of Power Engineers.** Annual convention and exhibition of power machinery at the Cleveland Auditorium, Cleveland, Ohio, Sept. 8-13. Secretary, Fred W. Raven, 417 South Dearborn St., Chicago, Ill.

**National Association of Practical Refrigerating Engineers.** Annual convention and exhibition at the Hotel Peabody, Memphis, Tenn., Nov. 11-14. Secretary, Edward H. Fox, 5707 West Lake St., Chicago, Ill.

**National Power Show.** Grand Central Palace, New York City, Dec. 1-6. Manager, Charles F. Roth, Grand Central Palace, New York City.

**Society of Industrial Engineers.** Seventeenth national convention at the Mayflower Hotel, Washington, D. C., Oct. 15-17. Secretary, George C. Dent, 205 West Wacker Drive, Chicago, Ill.

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# Trade Catalogs

VALVES—Bulletin No. 259-B of the Neilan Company, Ltd., 641-651 Santa Fe Ave., Los Angeles, Calif., describes an auxiliary pilot-operated level valve. Bulletin No. 260-B of the company contains information on an auxiliary pilot-operated float valve.

ASH CONVEYORS—"Modern Methods of Ash Handling" is the title of a new 24-page catalog illustrating several methods of handling ash by pipe line as well as other systems of ash conveying. The catalog is issued by the Brady Conveyors Corporation, 20 West Jackson Blvd., Chicago.

PUMPS—Many types of steam- and motor-driven vacuum pumps, pumps for handling heavy and light liquids, boiler-feed and hot-water pumps, filter-press pumps, and centrifugal pumps are described and illustrated in Bulletin No. 110 just issued by Guild & Garrison, Inc., 457 Kent Ave., Brooklyn, N. Y.

ELECTRICAL EQUIPMENT — Catalog GEA-600A, superseding all previous catalogs issued by the company with the exception of those dealing with railway, mine and industrial supplies and merchandise products, has just been issued by the General Electric Company, Schenectady, N. Y. Published every two years, the book this year contains 1,146 pages, 8x10½ in., and is profusely illustrated. It is thumb-indexed in sixteen sections as follows: Generation, wire and cable, distribution transformers, arresters and capacitors, voltage regulators, switching equipment, switchgear, meters and instruments, lighting equipment, motors, motor applications, industrial control, transportation, industrial heating, miscellaneous, and indices.

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# Fuel Prices

## COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

| Bituminous (Net Tons) | At Mine, for Shipment to | Price per Ton |
|---|---|---|
| Navy Standard | New York | $2.10 @ $2.30 |
| Kanawha | Cincinnati | 1.10 @ 1.35 |
| Smokeless | Cincinnati | 1.75 @ 2.00 |
| Smokeless | Chicago | 2.00 @ 2.25 |
| West Kentucky | Louisville | .85 @ 1.25 |
| Steam | Pittsburgh | 1.50 @ 1.60 |
| Gas Slack | Pittsburgh | .90 @ 1.10 |
| Big Seam | Birmingham | 1.60 @ 1.75 |

| Anthracite (Gross Tons) | At Mine, for Shipment to | Price per Ton |
|---|---|---|
| Buckwheat | New York | $3.00 |
| Barley | New York | 1.15 @ 1.50 |

## FUEL OIL

**New York**—Aug. 28, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 4.75c.@5.25c. per gal.; f.o.b. Bayway, 36@40 deg., furnace, tank-car lots, 6c.@6.25c. per gal.

**St. Louis**—Aug. 21, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.345 per bbl., or 42 gal.; 26@28 deg., $1.420 per bbl.; 28@30 deg., $1.520 per bbl.; 30@32 deg. $1.620 per bbl.; 32@36 deg., gas oil, 3.901c. per gal.; 38@40 deg., distillate, 4.526c. per gal.

**Pittsburgh**—Aug. 20, f.o.b. local refinery, 34@36 deg., fuel oil, 3.125c. per gal.; 36@40 deg., 3.25c.

**Philadelphia**—Aug. 14, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 18 deg. plus, $1.475@$1.525 per bbl.; 23@27 deg., $2.00@$2.05 per bbl.

**Cincinnati** — Aug. 19, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5.25c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.75c. per gal.

**Chicago**—Aug. 13, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., $0.90 per bbl.

**Boston**—Aug. 25, tank-car lots, f.o.b., 12@14 deg., Baumé, 3.3c. per gal.; 28@32 deg., 5c. per gal.

**Dallas**—Aug. 23, f.o.b. local refinery 26@30 deg., $1.10 per bbl. or 42 gallons.

# New Plant Construction

COMPILED BY THE McGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

**Ariz., Flagstoff**—U. S. Property & Disbursing Officer, Phoenix, received low bids for permanent National Guard encampment near here known as Fort Alexander M. Tuthill, 18 mess halls, power house and guard house from H. R. Meadows, Phoenix $55,746; administration building, infirmary, sewage disposal and water systems from Welton Builders, Denver, Colo. and warehouse from McGinty Construction Co., Phoenix, $18,681. Lescher & Mahoney, Phoenix, are architects.

**Calif., Modesto**—County of Stanislaus, is receiving bids for the construction of a 2 story power plant as third unit of County Hospital project. Estimated cost $30,000. R. DeLappe, 1710 Franklin St., Oakland, is engineer.

**Ga., Columbus** — Hospital Board, H. Hollis, Chn., received lowest bid for addition to and remodeling of city hospital including new boiler house and equipment from J. P. Bradfield, $88,412.

**Ill., Galesburg**—Chicago, Burlington & Quincy R.R., 647 Jackson Blvd., Chicago, awarded contract for the construction of an electric cinder plant in railroad yards here, to Roberts & Schaefer Co., 400 North Michigan Ave., Chicago. A. W. Newton, is chief engineer.

**Ind., Butlerville**—Feeble Minded School, will receive bids until Sept. 20, for the construction of a power plant and equipment. Estimated cost $50,000. O. B. Little, 307 North Illinois St., Indianapolis, is engineer.

**Ind., Evansville**—Bd. of Commissioners, will receive bids until Oct. 1, for the construction of a county infirmary including new power plant, two steam boilers, etc. Estimated cost $150,000. A. E. Neucks, Evansville, is architect.

**Ind., Indianapolis**—Indiana World War Memorial, M. S. Sonntag, Pres., St. Clair and Meridian Sts., will receive bids until Oct. 21, for the construction of a transformer and switchboard room. Walker & Weeks, 2341 Carnegie Ave., Cleveland, O., are architects.

**Mich., Detroit**—Malcolmson, Higginbotham & Trout, 1217 Griswold St., Archts., are receiving bids for the construction of a 4 story high school including faculty building, power plant with boilers and equipment on Cambridge St. for University of Detroit, Six Mile Rd. and Livernois Ave. Estimated cost $650,000.

**Mo., St. Louis**—Bd. of Education, 911 Locust St., will soon award contract for a 4 story, 101 x 150 ft. shop building including heating system, electric elevators, new boiler, resetting present boiler and piping in boiler room, new smoke stack, etc. Estimated total cost $245,000.

**Mo., St. Louis**—St. Louis Refrigerating & Cold Storage Co., 1300 Lewis St., awarded contract for a 65 x 70 ft. refrigeration plant and substation at 1304 Clark Ave. to McCormack-Combs Construction Co., Columbia Bldg. Estimated cost $40,000.

**N. J., Jersey City**—Bd. of Commissioners, City Hall, will receive bids about Sept. 15 for the construction of a 3 story, 40 x 66 ft. addition to hospital power house at Baldwin and Montgomery Sts. Estimated cost $150,000. J. T. Rowland, 30 Journal Sq., is architect.

**Ore., Hood River** — City Council, plans the construction of a hydro-electric power plant and distribution system for street lighting purposes. Plans include power house at Wilson St. reservoir, 175 ft. head; 75 kw. generating unit to connect with an overhead distribution system throughout residential part of city and a system of underground conduits for ornamental street lighting system in two of the business districts. Estimated cost $53,000.

**Pennsylvania**—Bureau of Fisheries, G. C. Leach, Washington, D. C., plans the construction of a 1 story, 30 x 32 ft. fish cultural station and sub-station here. Estimated cost $100,000 G. A. Schneider, c/o Bureau of Fisheries, 6th and B St., Washington, D. C., is architect.

**Pa., Pottstown**—Hill School, J. I. Wendell, Head Master, awarded contract for a 2 story, 78 x 181 and 107 x 148 ft. gymnasium and power plant to F. H. Keiser, 138 East 4th St.

**S. D., Pierre**—City awarded contract for the construction of a power plant to Gray Construction Co., Watertown. Estimated total cost $125,000. Contracts let for engines, generators and switchboard, etc.

**Tenn., Memphis**—City plans the construction of a new municipal water pumping station and extension of mains. Estimated cost $2,000,000.

**Tex., Schertz**—U. S. Government, c/o A. W. Parker, Constructing Quartermaster, having revised plans prepared for the construction of a 180 x 280 ft. post exchange building including cold storage plant at Randolph Field 14 mi. north of San Antonio. Estimated cost $60,000. R. B. Kelly, 336 Milan Bldg., San Antonio, is architect. Matthews & Kenan, Smith-Young Tower, San Antonio, are consulting engineers.

**Va., Hopewell** — Southside Marketing & Finance Corp., B. F. Harris, Petersburg, Pres., has been chartered with authorized maximum capital stock of $50,000 and plans the construction of a cold storage and refrigeration plant, here.

**W. Va., Moundsville**—City plans waterworks improvements including new electrically driven pumping plant. Estimated cost $50,000. D. Morrow, c/o Supervising Engineers Inc., 42 Cedar St., New York, N. Y., is engineer.

**Que., Buckingham**—James McLaren Co., Ltd., has filed application for permit to construct a hydro-electric development on the Lieore River. Plans include power house, dam and intake structure connecting intake by a tunnel to power house 587 ft. long. The dam will be 425 ft. long and contain eight stone gates, 24 ft. wide by 20 ft. deep and two waste gates 18 ft. wide, maximum elevation 384 ft.; four 28,000 hp. generators, four 30,000 hp. waterwheels and seven outdoor type transformers raising voltage to 220,000 v. Estimated cost approximately $10,000,000. Private plans.

## Equipment Wanted

**Electrical Equipment—Jersey City, N. J.**—State Highway Commission, A. L. Grover, Clk., Trenton, will receive bids until Sept. 15, for electrical equipment for transformer house Route 10, Section A, Contract 40, Newark Turnpike Bridge on Hackensack River, here.

**Engines—Whittier, Calif.**—City, D. E. Allen, Clk., will receive bids until Sept. 8 for one or more 2 cylinder 120 hp. gas engines equipped with muffler.

**Generating Set, Pumps, etc.—Miss., Fondron**—Bd. of Trustees, Mississippi State Hospital, will receive bids until Sept. 5, for one 200 to 300 kva. generating set steam direct connected to 3 ph. 60 cycle, 220 v. generator complete with exciter, switch panel, etc., one steam vacuum pump and one boiler feed pump (steam) repairing and altering three boilers for gas and furnishing and installing gas burners and equipment, 400 g.p.m. motor driven well pump and motor against 200 ft. head.

**Generator Sets—St. Louis, Mo.**—U. S. Engineers Office, 428 Custom House, will soon receive bids for one 1,000 and one 100 kw. generator sets d.c., also 1,000 hp. motor.

**Generator Sets, Boilers, Pumping Units, Etc.—Melville, R. I.**—Bureau of Yards & Docks, Navy Dept., will receive bids until Sept. 10 for removing and reinstalling three generator sets and furnishing four boilers with set oil pumping units, etc.

**Pump—Detroit, Mich.**—Dept. of Water Supply, D. Grobbel, Acting Secy., Bd. of Water Comrs., will receive bids until Sept. 23 for a 17 m.g.p.d. motor driven centrifugal pump against 180 ft. head for Springwells booster plant, Detroit water supply, West Warren Ave.

**Pump—Jamesburg, N. J.**—State Architect, Trenton, will receive bids until Sept. 10, for furnishing and installing a vacuum return pump for three cottages at State Home for Boys here. $10,000.

**Pump—Valleyfreed, Que.**—R. Belanger, City Engr., plans to purchase a 1,000 g.p.m. centrifugal pump for waterworks.

**Pumping Unit—Pettus, Tex.**—Central Power & Light Co., National Bank of Commerce, San Antonio, plans to purchase pumping unit for proposed waterworks system, here. Estimated cost $30,000.

**Pumps—Redwood City, Calif.**—City plans to purchase two 400 and two 1,200 g.p.m. pumps, etc. for proposed sewage treatment work. Estimated cost $120,500.

**Pumps—San Francisco, Calif.**—City will readvertise for bids soon for sixteen deep well turbine pumps for water department. Former bids rejected.

**Pumps—Livingston, Tenn.**—City, A. F. Officer, Recorder, will receive bids until Sept. 5 for a 250 g.p.m. marine engine driven centrifugal pump, 250 g.p.m. motor driven centrifugal pump, etc. for proposed waterworks system. Estimated cost $60,000.

**Pumps—Milwaukee, Wis.**—Dept. of Public Works, will receive bids until Sept. 9, for furnishing and installing three 2,500 g.p.m. motor driven centrifugal pumps in new fire service pumping station.

**Stokers—Salt Lake City, Utah**—Bd. of Education, will receive bids until Sept. 8 for two underfeed type stokers, one 1,200 lb. and one 700 lb. per hr. capacity.

## Industrial Projects

**Calif., Los Angeles**—Brunswig Drug Co., 501 North Main St., plans the construction of a manufacturing plant at Second St., Central Ave. and San Pedro St. Estimated cost $500,000.

**Calif., San Francisco**—Truscon Steel Co., Call Bldg., had plans prepared for the construction of a 1 story plant at Carroll and Newhall Sts. Estimated cost $50,000. Private plans. Crane will be installed.

**Calif., South San Francisco** — Pacific Coast Steel Co., 215 Market St., San Francisco, is having plans prepared for the construction of a plate manufacturing shop here. Estimated cost $60,000. Private plans.

**Conn., Danbury** — Danbury & Bethel Gas & Electric Light Co., 238 Main St., had plans made for a warehouse, garage and service building on State St. Estimated cost $50,000. Sunderland & Watson, 248 Main St., are architects.

**Conn., Torrington** — Torrington Casting Co., New Litchfield St., awarded contract for the construction of a 1 and 2 story brass casting shop and office to Longhi Construction Co., 42 Calhoun St. Waterbury. Estimated cost $40,000.

**Ill., Chicago**—Illinois Steel Co., 208 South La Salle St., will build a 1 story, 149 x 1674 ft. factory at 8345-61 Mackinaw St. here. Estimated cost $1,500,000. Work will be done by owners forces.

**Ill., Chicago**—Public Service Co., 72 West Adams St. (electric light manufacturers) awarded contract for the construction of a 2 story, 300 x 326 ft. service headquarters building at Dundee Rd. to Otto Randolph Inc., 53 West Jackson Blvd.

**Ind., Indianapolis**—Beach & Arthur Inc., 221 West South St., awarded contract for the construction of a 1 story, 200 x 300 ft. paper plant at 2900 Columbia Ave., to H. Fitton, 958 North Pennsylvania Ave. Estimated cost $75,000.

**Mo., Kansas City**—Corn Products Refining Co., 608 Brokers St., awarded contract for addition to plant to Bedford Construction Co., 200 East Illinois Ave., Chicago, Ill. Estimated cost $250,000.

**N. J., Linden** — John T. Norman, Inc., 400 Madison Ave., New York, N. Y., awarded contract for the construction of a 1 story, 142 x 225 ft. carpet factory here, to Austin Co., 120 Broadway, New York. Estimated cost $100,000.

**N. J., New Brunswick** — Goetze Gasket & Packing Co., Allen Ave., awarded contract for a 1 story addition to factory to J. Goodfriend, Boorum Ave., Middletown. Estimated cost $40,000.

**Pa., Neville Island**—Gulf Refining Co., Frick Bldg., Annex, Pittsburgh, awarded contract for the construction of a refinery to include 45 x 128 ft. machine shop, 50 x 80 ft. office, etc. here to W. F. Trimble & Sons Co., 1719 Pennsylvania Ave., Pittsburgh. Estimated cost $1,500,000. New working on plans for hot oil building, gas plant and pump house, compressor building, gas plant accumulator and pump house.

**Tex., Cuero**—Swift & Co., plans the construction of a 2 story, 48 x 51 ft., storage and packing plant including refrigerating unit for meat cooling and chicken freezing. Estimated cost $60,000. Private plans.

**Wis., Lodi**—Wrought Washer Mfg. Co., 46-54 South Bay St., Milwaukee, is having plans prepared for the construction of a 1 story, 65 x 500 and 65 x 385 ft. steel rolling mill and storage building here. Klug & Smith, 46-54 South Bay St., Milwaukee, is architect.

**Wis., Milwaukee**—Tiler & Stowell Co., 219 Becker St., (iron works) are receiving bids for a 3 story, 70 x 81 ft. factory. Private plans.

**Ont., London**—Taylor Electric Co., 526 Adelaide St., awarded contract for addition to factory for the manufacture of electrical supplies to Putherboygh Construction Co., London. Estimated cost $30,000.